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Testing And Data Recovery Excavations At The Jayroe Site (41HM51), Hamilton County, Texas

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TESTING AND DATA RECOVERY EXCAVATIONS AT THE JAYROE SITE (41HM51), HAMILTON COUNTY, TEXAS (WACO DISTRICT, CSJ NO. 0909-29-030)

by
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(Part I)
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with appendixes by
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Steve A. Tomka, Timothy K. Perttula, Leslie L. Bush, M. Steven Shackley,
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Austin, Texas

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and

COX|McLAIN Environmental Consulting, Inc.
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ABSTRACT

In 2003–2004, Prewitt and Associates, Inc., performed National Register of Historic Places testing and subsequent data recovery excavations at the Jayroe site (41HM51) in Hamilton County for the Texas Department of Transportation, Environmental Affairs Division, under Texas Antiquities Permit Nos. 3211 and 3405. The investigations were prompted by the planned replacement of the County Road 294 bridge at the Leon River (CSJ No. 0909-29-030), in compliance with Section 106 of the National Historic Preservation Act and its implementing regulations (36 CFR Part 800) and the Antiquities Code of Texas.

Testing consisted of the excavation of 6 backhoe trenches and 19 test units, and the data recovery work consisted mainly of hand excavation of 153 contiguous 1x1-m units within a single block, with 2 backhoe trenches and 2 manual units apart from the block excavation. Combined, the testing and data recovery identified 16 cultural features interpreted as 3 open hearths, 4 shallow earth ovens or surface hearths, 8 scatters of various kinds of debris, and 1 knapping station. The excavations recovered 322 chipped stone tools, 26 cores, 6,589 pieces of unmodified debitage, 21 ground or battered stone tools, 38 potential pigment sources, 43 ceramic sherds, 15 modified bone artifacts, 7,649 animal bones, 1,200 mussel shells, and macrobotanical remains. Four analytical units are defined for the site, only one of which—the Toyah phase component—has much interpretive potential. It is interpreted as a campsite used at least several times, mostly in the A.D. 1470s, at which butchering of mostly bison and deer, late-stage lithic tool manufacture and repair, and other maintenance tasks figured prominently in the site activities.

The artifacts recovered and records generated by the project are curated at the Center for Archaeological Studies, Texas State University.

ACKNOWLEDGMENTS

A project with a history as long as this one presents challenges when it comes to identifying all the people who contributed to it, so we apologize to any we have omitted. At the Texas Department of Transportation (TxDOT), Jon Budd oversaw the work, and David Jayroe of the Waco District provided logistical support for the fieldwork; the site was named for David to honor his contributions. At Prewitt and Associates, Inc. (PAI), Karl W. Kibler served as principal investigator and geoarcheologist up until 2017, after which Ross C. Fields took over principal investigator duties. Cory Broehm served as project archeologist for both phases of fieldwork, with field crew consisting of Jennifer McWilliams, Rob Thrift, Weldon Hammond III, Greg LaBudde, Mark Holderby, Roman Clem, Jon Grant, Jim Gillentine, Tim Gibbs, Matt Stotts, and Michael Aiuvalasit. Rob Thrift did much of the laboratory work and the curation preparation. John E. Dockall and Eloise F. Gadus analyzed the lithic and ceramic artifacts, respectively, with Dockall joining Karen M. Gardner to analyze the invertebrate faunal remains and Dockall alone doing the fragmentation and FFI analysis of the animal bones. Brian Wootan photographed the artifacts, Sandra Hannum prepared the graphics for the report and laid it out, and Ross C. Fields edited the report. The various specialists included J. Michael Quigg (vertebrate faunal remains), Leslie Bush (botanical remains), Jeffrey R. Ferguson and Michael D. Glascock (neutron activiation analysis), Lori Barkwill-Love (petrographic analysis), Steve A. Tomka and Timothy K. Perttula (assessments of NAA and petrographic data), M. Steven Shackly (XRF analysis), and Linda Scott Cummings and Caitlin Clark (organic and protein residues).

Many authors contributed to the body of Part 1 of this report, as listed below. Authorship of Appendixes A–H is indicated on the title pages.

Chapter 1: Karl Kibler and Cory Broehm (project history and environmental setting), John Dockall (summary of cultural history), and Ross Fields (project history and report organization.

Chapter 2: Karl Kibler and Cory Broehm (National Register test excavations and data recovery investigations) and John Dockall, Eloise Gadus, and Ross Fields (analysis methods).

Chapter 3: Karl Kibler and Jon Budd.

Chapter 4: Karl Kibler and Ross Fields.

Chapter 5: Karl Kibler and Cory Broehm (cultural features), John Dockall (the lithic assemblage, the vertebrate faunal assemblage, and the invertebrate faunal assemblage), Karen Gardner (the invertebrate faunal assemblage), Eloise Gadus (the ceramic assemblage), and Ross Fields (cultural features, the lithic assemblage, the ceramic assemblage, and macrobotanical remains).

Chapter 6: Ross Fields and John Dockall.

Chapter 7: Ross Fields and John Dockall.

Chapter 8: Ross Fields.

An unusual aspect of this report is that it consists of two separate parts. Part I was prepared by PAI personnel and was submitted, along with Appendixes A–I, in draft form to

TxDOT in June 2018. Because TxDOT archeologist Jon Budd had a vision of what constituted appropriate analysis and reporting for the project that differed from that of PAI, TxDOT contracted with AmaTerra Environmental, Inc., to conduct additional, independent analyses. Budd and AmaTerra personnel and consultants (Katherine Seikel, Rachel Feit, Timothy Griffith, Mindy Bonine, Jodi Jacobson, Susan Sincerbox, Taylor Bowden, and Harry Shafer) prepared a report on this work, completed in draft form in November 2019, to be incorporated into this volume as Part II and Appendixes J–L. AmaTerra personnel did all editing and formatting of these parts of the report. The PAI and TxDOT/AmaTerra efforts were not integrated, and hence the useful information that Part II offers, in particular the detailed faunal analysis in Appendix J, is not reflected in Part I. Instead, Part I relied on the results of the initial faunal analysis presented in Appendix A.

PART I

TESTING AND DATA RECOVERY EXCAVATIONS AT THE JAYROE SITE (41HM51), HAMILTON COUNTY, TEXAS (WACO DISTRICT, CSJ NO. 0909-29-030)

edited by

Ross C. Fields

Principal Investigators: Karl W. Kibler and Ross C. Fields

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CHAPTER 1: INTRODUCTION AND BACKGROUND INFORMATION

From ancient trails to early exploration routes, Texas's roads always connected people and goods. In the early twentieth century, the newly formed Texas Highway Department eased travel and increased safety for a growing population. Today, more than 600,000 miles of road span the state—more than any other state in the nation. Starting with Highway 1 nearly 100 years ago to today's expansive roadway system, TxDOT still connects people to their destinations.

The Archeological Studies Program, part of TxDOT's Environmental Affairs Division, plays a unique role telling a story about these roads, what came before them and what developed along them. Federal and state laws guide these efforts. Any time TxDOT plans road projects, TxDOT considers the places on the landscape that people settled and how the landscape has been changed by modern conditions. TxDOT's investigations address the effects of proposed projects on important archeological sites, while meeting the agency's mission to deliver a safe and reliable transportation system. It is part of TxDOT's environmental work that goes Beyond The Road.

The Archeological Studies Program includes 10 archeologists with expertise in various fields of archeology, such as geoarcheology, stone tool analysis, and regional culture history. The range of expertise allows for a thorough and good faith effort to identify, assess, and evaluate archeological sites throughout the state. The level of effort varies among projects. While TxDOT archeologists review hundreds of projects a year, only one or two of these projects may contain a site that merits extensive excavation. TxDOT documents the site in a technical report as well as conducts outreach to educate the public about its history in the spirit of historic preservation laws.

This report describes one such excavation in Hamilton County. The report is a comprehensive technical document, detailing the work performed, the observations made, and the resulting conclusions. The excavations, which consisted mostly of hand-dug units but also included some work by heavy machinery, found that Native Americans used the site as a temporary camp, mostly about 500–600 years ago. They left behind the remains of many campfires used to cook food and provide heat and light, along with more than 7,000 stone and ceramic artifacts representing tools they made and used and 7,600 animal bones and 1,200 mussel shells representing animals they hunted or collected. The intended audience for this report is avocational and professional archeologists, students, and researchers. More general information about TxDOT's work and some of the exciting investigations led by TxDOT archeologists can be found on TxDOT's website. Go to www.txdot.gov and search, using the keywords "archeology" or "beyond the road."

This report is on National Register of Historic Places testing and subsequent data recovery excavations at the Jayroe site (41HM51). Prewitt and Associates, Inc., performed the work for the Texas Department of Transportation, Environmental Affairs Division (TxDOT-ENV), in 2003–2004 under Texas Antiquities Permit Nos. 3211 (testing) and 3405 (data recovery). The investigations were undertaken in conjunction with replacement of the County Road 294 bridge at the Leon River in Hamilton County (CSJ No. 0909-29-030; Figure 1.1) in compliance with Section 106 of the National Historic Preservation Act and its implementing regulations (36 CFR Part 800) and the Antiquities Code of Texas. This project involved replacing the ca. 1890 bridge with a new structure located 55–61 m west (upstream) of the old bridge and reworking the approaches; it required 1.72 acres of new right of way on both sides of the river. Survey in 2003 identified 41HM51 and 41HM46 in new right of way on the north and south banks of the river, respectively (Kibler 2003); both sites were tested in late 2003–early 2004 (Broehm et al. 2004). The Jayroe site was judged eligible for National Register listing and thus worthy of data recovery excavations, which were performed soon after completion of the testing project (April–July 2004) because of impending construction of the bridge. A separate report on the work at 41HM46, which was assessed as ineligible for National Register listing, was produced in 2011 (Dockall et al. 2011).

PROJECT HISTORY

The testing and data recovery were done under eight work authorizations. The first (WA 57309SA001, PAI 203032, August 2003–February 2004) consisted of testing fieldwork at 41HM51 and 41HM46 and producing an interim report (Broehm et al. 2004). The second (WA 57314SA001, PAI 204013, April 2004–October 2004) consisted of data recovery fieldwork, followed by preparation of an interim report (Broehm and Kibler 2004). The third (WA 57505SA006, PAI 205006, February 2005–March 2007) involved preparing a preliminary research design to guide completion of the project. The fourth (WA 57549SA006, PAI 206045, September 2006–June 2007) was an initial, ultimately abandoned attempt to implement the research design. The fifth (WA 57915SA002, PAI 210043, December 2010–March 2011) consisted of limited planning efforts for finishing the project after it had been put on hold for several years. The sixth (WA 57303SA003, PAI 213027, November 2013–March 2015), entailing a variety of analysis tasks, represented the first successful attempt to move the project forward since completion of the fieldwork more than nine years earlier. The seventh (WA 57507SA004, PAI 216001, February–April 2016) consisted of preparing a final research design for completing the project. The eighth (WA 57701SA003, PAI 217004, March 2017–October 2020) consisted of finishing data analysis, preparing this report, and preparing the materials recovered and records for curation.

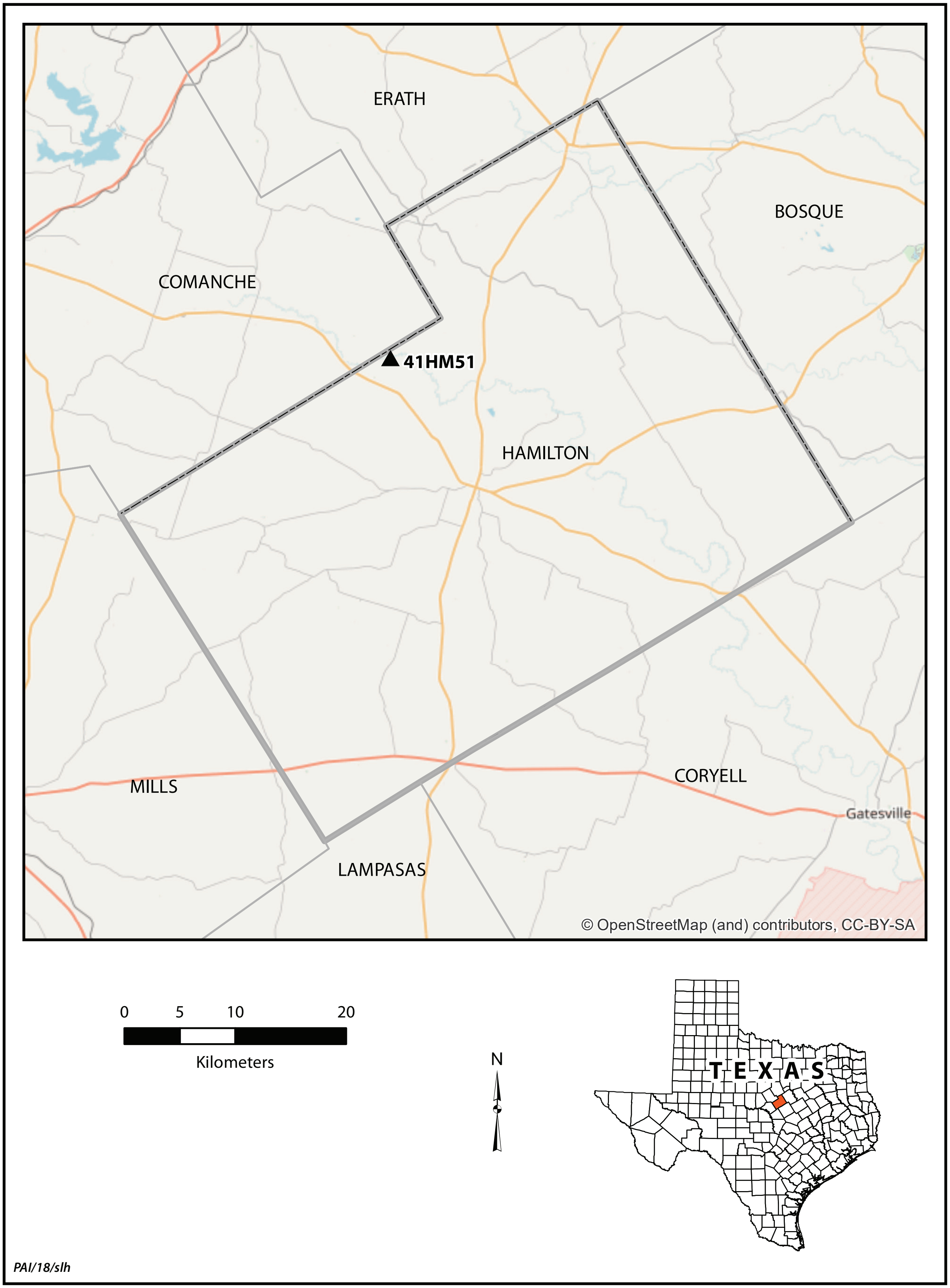


Figure 1.1. Map showing location of the Jayroe site, 41HM51, on the Leon River.

ENVIRONMENTAL SETTING

The Jayroe site is near the northwest boundary of Hamilton County, 0.8 km southeast of the Hamilton-Comanche County line and 14 km northwest of the center of the town of Hamilton. The project area is in the Limestone Cut Plain portion of the Cross Timbers ecoregion, as defined by Griffith et al. (2007:41–43). The Limestone Cut Plain is bordered on the west by Lower Cretaceous sandstones that support oak woodlands of the Western Cross Timbers, on the east by the nearly level to rolling tall grasslands of the Blackland Prairie, and on the north by a transition to the smoother topography of the Grand Prairie (Figure 1.2). The southern boundary is a transition to the Balcones Canyonlands, characterized by its highly dissected canyons, spring-fed streams, and oak/Ashe juniper woodlands.

Mesas with broad intervening valleys forming a two-tiered landscape characterize the Limestone Cut Plain (Griffith et al. 2007:41–42). Although Lower Cretaceous Edwards Limestone caps the highest mesas, the Limestone Cut Plain is distinguished from the Edwards Plateau by a more-variable geology, which includes carbonate rocks of the Walnut and Glen Rose Formations (Bureau of Economic Geology 1976). These formations are the substrates of the broad intervening valleys and the late Quaternary stream valleys incised into the broader valleys, respectively. In addition, greater precipitation compared to the Edwards Plateau has led to increased erosion and dissolution of the limestone layers resulting in the landscape characteristics of today.

The soils mantling the carbonate rocks are shallow and support a variety of woodland and grassland vegetation (Griffith et al. 2007:42). The woodland vegetation is similar to that of the Balcones Canyonlands, although less diverse. It includes plateau live oak, cedar elm, Texas ash, big tooth maple, and bur oak. Other endemic Edwards Plateau plant species are prevalent. The mesa divides support an oak savanna. The dry rocky slopes have little soil and support a sparse cover of shin oaks, sumacs, and Ashe junipers. The broad intervening valleys generally contain grasslands of mid and short grasses. Unlike the Edwards Plateau, the Limestone Cut Plain grasslands also contain tall-grass species. Presettlement grasslands included species such as big bluestem, little bluestem, yellow Indiangrass, tall dropseed, and sideoats grama. With concentrated cattle grazing, these grasses have been replaced by species such as silver bluestem, Texas wintergrass, and purple threeawn. The late Quaternary stream valleys support riparian communities of deciduous oaks, hackberries, elms, and sycamores. As in other limestone regions of central Texas, grazing along with fire suppression have changed the nature of the oak savannas and grasslands through the expansion of Ashe juniper and mesquite.

Fauna of the region are characteristic of the Texan and Balconian biotic provinces (Blair 1950:100–102, 112–115). Forty-nine species of mammals, 2 species of turtles, 16 species of lizards, 39 species of snakes, and 23 species of amphibians have been documented in the former province in modern times, and 57 species of mammals, 1 species of turtle, 16 species of lizards, 36 species of snakes, and 23 species of amphibians are known for the latter, with some overlap between the two assemblages.

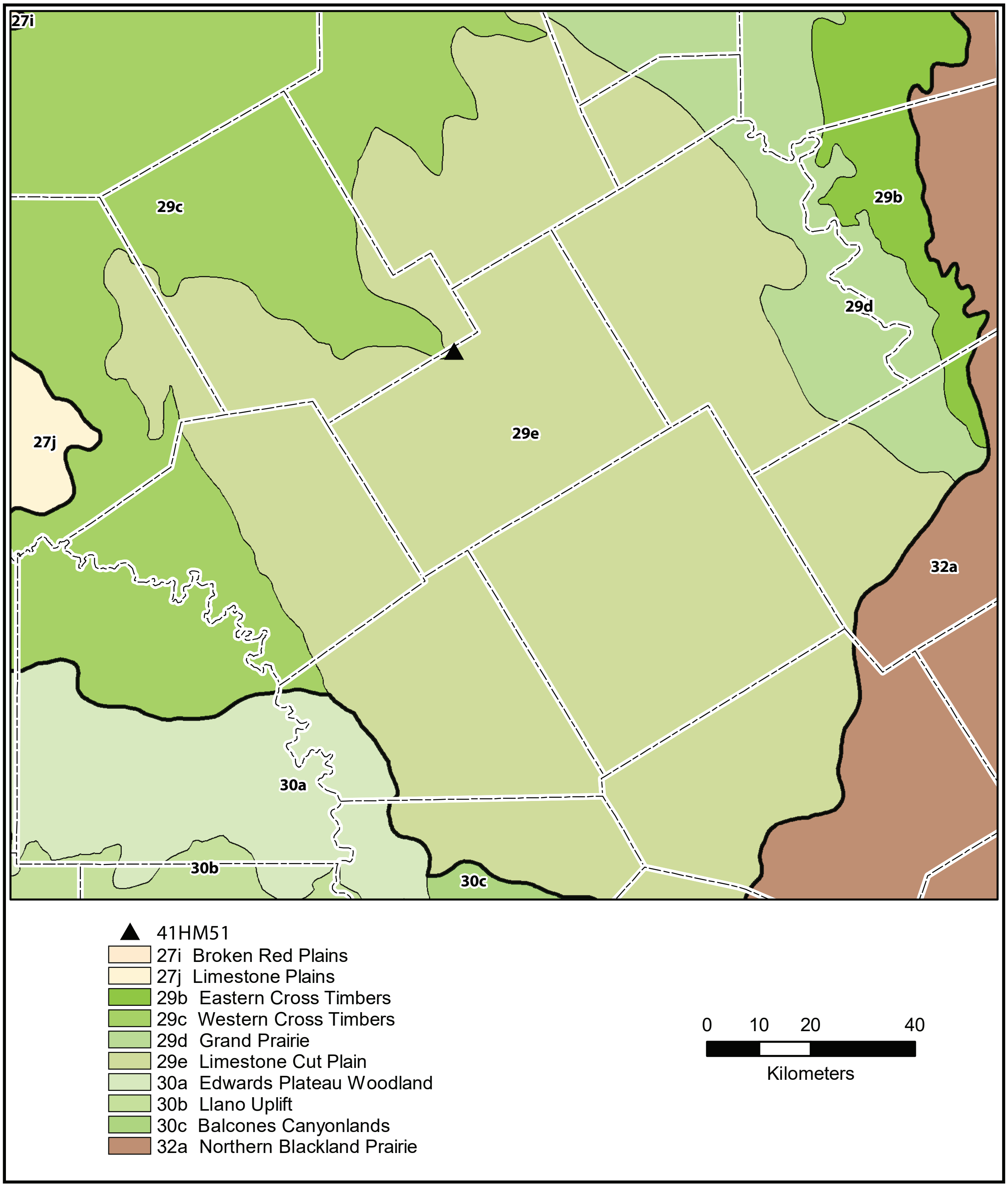


Figure 1.2. Map showing the location of the Jayroe site relative to ecoregions (from Griffith et al. 2007).

Rainfall averages 29.8 inches annually in Hamilton County; it is equably distributed throughout the year, except for minor peaks in April–May and September–October (Natural Fibers Information Center 1987:215–216). Daily maximum and minimum temperatures average 79 and 53°F; the highest maximum average is 97°F (July and August), and the lowest minimum average is 33°F (January). The growing season averages 239 days, extending from late March to late November (Natural Fibers Information Center 1987:215–216).

The site is along the middle reach of the Leon River, which is part of the Brazos River drainage system. The Leon River joins the Lampasas River to form the Little River about 120 km to the southeast, near Belton, Texas; from there, the Little River flows another 71 km to the east-southeast before joining the Brazos River. The Leon originates 84 km northwest of the project area near Eastland, Texas. Two large northside tributaries, Rocky Creek and Resley Creek, join the river 0.1 and 1.6 km west (upstream) of the site, and a minor tributary, Alex Branch, flows into it 1.1 km to the east-southeast. An old channel of the river is mapped starting 0.2 km southeast of the project area and ending at the present river channel 4 km downstream, where the only significant southside tributary in the vicinity, Warren Creek, joins the river.

At 41HM51, the Leon River flows east through the center of a 1.3-km-wide flat floodplain at an elevation of 1,020–1,040 ft above mean sea level. The valley walls to the south and north rise moderately to interfluve crests at elevations of 1,120 ft overlooking the floodplain. One segment of north valley wall 1.4 km northeast of the site is a steep bluff rising to 1,178 ft above mean sea level. The Bureau of Economic Geology (1976) maps Holocene alluvium across the project area. The alluvium is flanked by the Lower Cretaceous Glen Rose and Twin Mountains Formations. The site is situated on the T_{1a} terrace on the north side of the river. The terrace stands ca. 6 m above the channel, and soils of the Frio series are mapped on the terrace surface (Allison 2007). These soils are described as grayish brown to very dark grayish brown silty clays, generally at least 1.78 m thick, and are found on bottomlands with 0–1 percent slopes. They form in calcareous loamy and clayey alluvium (Allison 2007:141).

SUMMARY OF CULTURE HISTORY AND CULTURAL CONTEXT

Decades of archeological investigations across the central Texas region have revealed a ca. 13,000-year-long record of hunting and gathering peoples using a diverse array of tools, features, and other materials to exploit a variety of resources. Albeit a seemingly conservative and little-changing way of life for millennia, it was a successful adaptation to the risks posed by environmental changes that occurred at the end of the Pleistocene and throughout the Holocene. The hunting and gathering subsistence pattern of the Archaic period continued relatively unchanged through the first part (Austin phase) of the Late Prehistoric period (Collins 2004:122; Johnson and Goode 1994; Prewitt 1981). By the latter part (Toyah phase), significant changes had occurred, including the shift to a single dominant arrow point style (Perdiz), a focus on hunting both bison and deer, and the use of a lithic technology dominated by large thin bifaces, Perdiz arrow points, end scrapers, and prismatic blades.

This archeological record has been summarized by many over the decades (e.g., Black 1989; Collins 1995, 2004; Johnson and Goode 1994; Johnson et al. 1962; Lohse, Black, and Cholak 2014; Prewitt 1981, 1985; Sorrow et al. 1967; Weir 1976). Carpenter and Houk (2012) provide a review and critique of the various cultural chronologies used for the region, particularly noting the terminology used by each researcher for subdividing the last ca. 3,100 years of the record, the meanings of these terms, and the chronological beginnings and ends for each subdivision. Despite the array of divisional terms used and various named phases, intervals, and patterns, there is general agreement between the different chronologies. The following summary focuses only on the last 500 years of this sequence, i.e., the Toyah phase, since the archeology at the Jayroe site is largely restricted to this interval.

Toyah as an Archeological and Cultural Concept

The term Toyah has been used to refer to a focus, a phase, and a ceramic and lithic technocomplex of the Late Prehistoric period in central and south Texas. It spans a time range between A.D. 1250 and 1700 (Carpenter 2017:1). There are multiple interpretations regarding its origins. These include migration or diffusion, use of the same technology by related groups or multiple ethnicities, development of target-specific technologies by bison-hunting groups, and more recently the technology of "dual economy long-range seasonal hunters" (following Carpenter 2017:2). Each of these is briefly discussed below.

J. Charles Kelley identified Toyah as the diffused archeological manifestation of the Jumanos of southwest Texas and northeastern Mexico (Kelley 1947a:103, 1955, 1986:102–109). His conclusions were based on his early research in the La Junta de los Rios region of Coahuila and adjacent Texas and later work at such sites as Lehmann Rockshelter, Buzzard Cave, and Fall Creek Site No. 3 (Arnn 2012a:52; Jackson 1938; Kelley 1986:95–109). The concept was later refined by Suhm, Jelks, and others (Jelks 1962; Suhm et al. 1954). From Lehmann Rockshelter, Kelley (1947b:122–123, 1986:102) described the Toyah lithic assemblage as consisting of Perdiz and Cliffton arrow points, snub-nosed scrapers, small awls, drills with flake bases, double-pointed blades or knives with alternately beveled edges, blades, and tubular bone beads. The ceramic assemblage typically consisted of undecorated bone-tempered vessels (bowls, ollas, and occasional jars) in a buff color (Leon Plain) and red-slipped (Doss Redware) varieties with some vessels having burnished, oxidized, brushed, or punctated exterior surfaces (Arnn 2012a:53). In Kelley's (1955) view, the lithic technology spread across much of Texas as the Jumano people moved across the state.

Countering this migration interpretation, based on his work at the Kyle site, Jelks (1962:91) interpreted the Late Prehistoric Austin focus as having directly descended from the earlier Archaic Edwards Plateau aspect, with the Austin focus giving rise to the Toyah focus. Jelks saw little technological distinction between the earlier Archaic Central Texas aspect and subsequent Late Prehistoric Austin focus assemblages, except for a shift from dart points and the atlatl to arrow points and the bow. Differences between Austin and Toyah focus assemblages were interpreted as replacement of certain older styles with new ones, principally arrow points and ceramics, with the adoption of new styles/traits reflecting diffusion into the region from surrounding areas. Johnson (1994:241) notes that Jelks's understanding and linear interpretation of an Austin to Toyah succession was flawed and based on rockshelter assemblages. Subsequent work by Story and Shafer (1965) at the Baylor and Britton sites in McLennan County led to the identification of greater differences between Austin and Toyah assemblages than between Austin and preceding Archaic period assemblages.

Later, Johnson (1994) interpreted ceramic and lithic technologies and stylistic attributes of assemblages from Buckhollow and other sites as representing a single group or multiple related groups sharing technologies and styles. The origin of this group or groups was considered to have been the Plains or Mogollon regions. Ricklis's (1992, 1994) work on Rockport sites on the Texas coastal plain and at the Barton (41HY202-A') and Mustang Branch (41HY209) sites in Hays County led him to argue that the Toyah complex was a toolkit that was commonly shared across group or social boundaries. Diffusion of ideas and technology was seen as the most parsimonious explanation for the spread and distribution of Toyah complex material across central and southern Texas. Black (1986) and Ricklis (1994:208) also argued for a reconsideration of terminology away from foci and phases, which suggested a greater degree of sociocultural uniformity than appeared to be demonstrated by Toyah sites. Ricklis (1994:208) suggested that the term "technocomplex" (as defined by Clarke 1968) fits well with the known character and distribution of Toyah material. Clarke (1968:495) defines a technocomplex as "a group of cultures characterized by assemblages sharing a polythetic range but differing specific types of the same general families of artefact-types, shared as a widely diffused and interlinked response to common factors in environment, economy, and technology." Clarke indicates that technocomplexes do not necessarily reflect "social, linguistic or cultural uniformity," and sometimes distinctive artifact types and associated behaviors may be found to occur beyond the technocomplex area. But it is only within the technocomplex area that the types and behaviors become integrated into a coherent entity (Clarke 1968:340–341).

More recently, researchers have emphasized that Toyah lithic and ceramic technologies were designed specifically for hunting, procuring, and processing bison, with profound behavioral and technological links between the assemblages and reliance on bison as a subsistence and economic resource (Black 1986, 1989; Carpenter 2017:4; Collins 2004:123; Creel 1990, 1991). Prewitt (2012:188–189) suggests that this is more of a tacit impression, however, and that emphasis on bison and the associated toolkit has served primarily as a way to isolate Toyah from previous cultural patterns. Most recently, researchers have argued for a broader-spectrum interpretation of the Toyah subsistence economy (Arnn 2012a, 2012b; Carpenter 2017; Gilmore 2012; Mauldin et al. 2012).

Within the last two decades, research has expanded to include social identity, social boundaries, and attribution of the Toyah technocomplex to specific groups—

including the Jumano, Tonkawa, Southern High Plains groups, and various Gulf coast groups—and the social and economic interaction between different groups (Ahr 1998; Arnn 2012a, 2012b; Boyd 2012; Brosowske 2004; Carpenter 2017:4; Kibler 2012; Speth and Newlander 2012). The foundation of these approaches can be found in work by Kenmotsu (2001), Mallouf (1999), and Wade (1998, 2003), among others in Texas, and similar research on the Southern High Plains (Baugh 1986; Baugh and Nelson 1987; Habicht-Mauche 1987; Lintz 1979; Vehik 2002).

Carpenter (2017) proposes a revised interpretation of the Toyah complex as the archeological manifestation of a dual-economy system of agriculturalists and maritime-adapted groups participating in seasonal long-range hunting efforts. In his view, participating groups could have included agriculturalists such as the Caddo (Hasinai and Nabadeche) from east Texas, as well as people living in the La Junta area of the Trans-Pecos and the Pecos River valley (Carpenter 2017:13). Others could have included any of the number of groups situated in the Texas interior and along the Gulf coastal plain (Campbell 1988; Ricklis 1992; Wade 1998, 2003).

Toyah Regional Geography and External Relationships

Collins (2004) subdivides the Late Prehistoric period into early and late subperiods that correlate to the Austin and Toyah intervals, respectively. The Austin interval (A.D. 700–1300) is more akin to the preceding Late Archaic period in terms of subsistence economy, differing primarily in a technological change from dart points and atlatl to the bow and arrow (Johnson and Goode 1994; Prewitt 1981). The Toyah interval (A.D. 1300–1750) differs considerably in the predominance of the Perdiz arrow point style, presence of local and nonlocal ceramics, and a technology that emphasizes big-game hunting, primarily bison (Collins 2004:122–123). Johnson and Goode (1994:40–41) consider the shift from an Archaic lifestyle at the end of the Austin interval and the beginning of the Toyah interval (following Collins) to be the result of an environmental and climatic shift from mesic to more-xeric conditions that probably fostered a return of greater numbers of bison into the region.

The geographic distribution of the Toyah phase includes much of central Texas and adjacent portions of the Rolling Plains, Lampasas Cut Plain, Blackland Prairie, Gulf coastal plain, and south Texas (Kenmotsu and Boyd 2012a:2). Geographic depictions of Toyah have their origins in early work by Kelley (1947a, 1986). Changes in thinking about Toyah as a phase rather than a focus by Jelks (1962) and later revision of the Toyah phase by Prewitt (1981) expanded the geographic reach to the eastern and northeastern edges of the Edwards Plateau. Johnson (1994) added to the geography by including the San Angelo/Concho River region as part of the "classic Toyah" heartland (Figure 1.3).

Many of the perceptions, understandings, and thoughts (both theoretical and practical) concerning Toyah as an entity have been guided by Johnson's idea of "classic Toyah" and "shared Toyah" areas (Johnson 1994:243, Figure 105). The former is smaller than the latter, with the Edwards Plateau forming its heartland. Sites attributed to classic Toyah have artifact assemblages containing most or significant portions of the typical ceramic and lithic characteristics, frequently

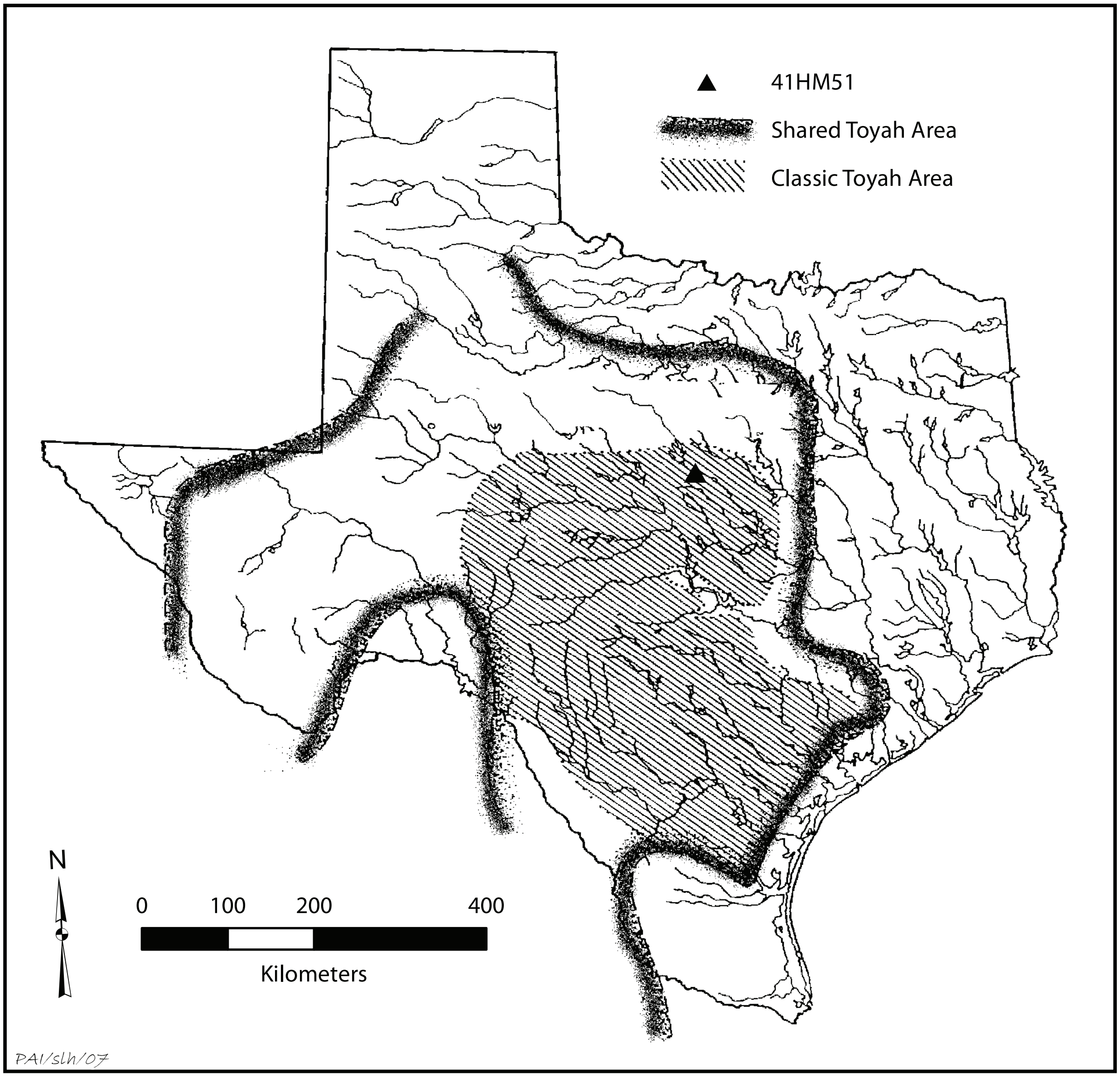


Figure 1.3. Map showing the location of the Jayroe site relative to Johnson's (1994:Figure 105) classic Toyah region and shared area.

associated with bison remains (Arnn 2012a:58). Classic Toyah ceramics commonly are locally manufactured plain utilitarian vessel forms that are low fired with bone temper (Johnson 1994:206). Arnn (2012a:58) notes that the more-extensive shared Toyah area has many sites having at least a few elements of the lithic, ceramic, and faunal assemblages characteristic of Toyah sites. The shared Toyah area includes archeological manifestations like the Cielo complex in west Texas (Mallouf 1999), the Garza complex in the Southern High Plains (Boyd 2012), and Rockport phase sites along the Gulf coast (Ricklis 1992, 2004).

One of the key aspects of the Toyah phase described by Prewitt (1981:84) is the importance of external relationships with other groups. Most visibly, these relationships are reflected in variation in ceramic assemblages, such as the presence of Rockport phase asphaltum-decorated ceramics in south Texas sites and Caddo-style ceramics in sites situated on the Blackland Prairie and Lampasas Cut Plain (Arnn 2012a:58). Because external relationships, regional exchange networks, and the identification of social boundaries and social identities are such prominent topics in Toyah research, the following sections examine the adjacent cultural groups and regions.

Northern Toyah, Panhandle-Plains, and Plains Village

As early as 1946, Krieger discussed the presence of Toyah diagnostic artifacts like Perdiz arrow points and beveled bifacial knives in north Texas and Panhandle sites also having Caddo- and Southwestern-style ceramics. His review emphasized relationships among the various Plains Village groups. Plains Village groups known by such terms as Antelope Creek, Buried City, and Henrietta complex, among others, appeared in the Panhandle-Plains region during the latter part of the Late Prehistoric period. The typical Plains Village subsistence economy included growing maize, beans, and squash and hunting bison (Drass 1998). The Henrietta complex in north-central Texas is the southernmost expression of the Plains Village culture in the state (Boyd 1997; Krieger 1946) and spans the transition between the Late Prehistoric and Protohistoric periods. While still not well known, the Henrietta complex lithic assemblage exhibits many parallels to Toyah assemblages but also commonly includes Fresno, Washita, Scallorn, and Harrell arrow points, and occasionally Perdiz, Alba, and Bonham styles (Arnn 2012a:59; Boyd 1997:360).

For the Panhandle and Caprock Canyonlands regions of Texas, south and west of areas occupied by Plains Village groups, the latter part of the Late Prehistoric period includes both the Tierra Blanca and Garza complexes, which have demonstrated relationships with adjacent groups to the east, west, and south. These complexes fall within Boyd's (1997, 2001, 2012) northern Toyah study area and appeared in the archeological record by about A.D. 1300. Boyd's (1997:419–481) summary of them concludes that they represent minor variations of the same cultural group or, more likely, similar but distinct contemporaneous groups. Evidence from a few sites suggests that the northern Edwards Plateau was occupied and utilized at the same time by both Toyah phase and Garza complex people (Boyd 1997:363).

The northern Toyah area consists of overlapping ranges for several different styles of arrow points and ceramic types between A.D. 1300 and 1700 (Boyd 2012:134). Arrow point styles include Perdiz, Cliffton, Garza, Lott, Washita, Harrell, and Fresno, and ceramic styles include plain brown wares, Jornada Brown, Three Rivers Red-on-terracotta, El Paso polychromes, Rio Grande glaze wares, Tewa Polychrome, Los Lunas Smudged, Mimbres-Mogollon painted wares, and Kowina Black-on-white. Also mentioned are an array of other less-common styles that include cord-marked, engraved, shell-tempered, and corrugated wares. Evidence from a number of sites along the margins of the classic Toyah area and in the shared Toyah area indicates that multiple distinct cultural groups cooperated in group bison hunts. This is reflected in the presence of multiple styles of arrow points that co-occur in good archeological contexts (Quigg 1997; Quigg and Peck 1995; Runkles 1964; Treece, Lintz, et al. 1993).

The Edwards and Wheeler phases of western Oklahoma date to A.D. 1500–1650 and 1650–1750, respectively, and overlap temporally with Garza complex sites in Texas. Garza complex and Wheeler phase sites have some similarities in arrow point styles and tool types that are shared by Garza and Toyah sites. These include Fresno, Garza, Harrell, and Washita arrow points; beveled bifacial knives; and end scrapers and drills. There are also close similarities in shared ceramic types, representing a variety of southwestern and Southern Plains styles. These sites document considerable interaction with Puebloan groups to the west based on ceramic styles, obsidian artifacts, and a variety of lithic materials like Alibates, Florence-A, Tecovas, and Edwards cherts (Baugh 1986).

Obsidian sourcing studies (Baugh 1986; Baugh and Nelson 1987; Brosowske 2004; Habicht-Mauche 1992; Kibler 2012) document the presence of exchanged obsidian in shared and classic Toyah sites and in the northern Toyah area. The obsidian originated from sources to the west-northwest and demonstrates that groups in the Panhandle-High Plains region likely participated in panregional exchange and interaction networks Other exotics include *Olivella* shell ornaments, turquoise, clay pipes, and occasional pieces of copper, in addition to Caddo and Southwestern ceramics (Drass 1998:421; Vehik 2002). Baugh (1980; Baugh and Nelson 1987) postulates that by about A.D. 1450 a realignment of exchange and interaction between Pueblo and Plains Village groups favored New Mexico obsidian sources. He suggests that obsidian procurement was direct between these groups, with little evidence of down-the-line exchange. The small amounts of this obsidian that have been recovered from Garza complex, Wheeler phase, and Toyah and other sites, coupled with the occasional presence of Southwestern-style ceramics or locally made ceramics based on Puebloan prototypes between A.D. 1500 and 1700, may support this interpretation (Habicht-Mauche 1987). The obsidian that has been documented in Toyah sites is as ephemeral as that for Garza and Wheeler sites and suggests that Toyah people procured their obsidian from other Southern Plains groups rather than directly from Puebloan intermediaries. Rightly, Kibler (2012:84) notes that obsidian, ceramics, and other exotic artifacts are mainly present in Toyah sites located along the margins of the classic Toyah area.

Toyah people interacted directly with people of the Garza complex and other adjacent culture areas, and that interaction was sometimes tenuous and violent (Boyd 1997:364; Speth and Newlander 2012:171–172; Vehik 2002:41–43). The vast majority of the evidence of interpersonal violence appears to concentrate in the northern Toyah area, corresponding to the northern edge of the Edwards Plateau and adjacent Southern High Plains, rather than extending south into the classic Toyah area.

Jornada Mogollon

Portions of eastern New Mexico, western Texas, and Chihuahua are included in the homeland of the Jornada Mogollon (Lehmer 1948; Speth and Newlander 2012:153), a Puebloan manifestation centered on the Rio Grande valley in the area of El Paso, Texas. Development of the Jornada Mogollon occurred during the Formative period (A.D. 200–1450) in the western Trans-Pecos region but culminated in the El Paso phase (A.D. 1250/1300–1450), which was roughly coeval with Kelley's La Junta phase (A.D. 1200–1400) to the south in the Big Bend region (Kelley et al. 1940; Miller and Kenmotsu 2004:237–238). The El Paso phase is characterized by surface pueblo construction, well-developed religious and social systems, an agricultural economy, and reduced settlement mobility with the population concentrated along well-watered drainages and locations (Miller and Kenmotsu 2004:238). Speth and Newlander (2012:153–154) emphasize that the region of eastern New Mexico and western Texas encompassed by the Pecos River valley to the Llano Estacado represents an important zone of Plains-Pueblo interaction.

Between A.D. 1250/1300 and 1450, the archeological record indicates increased agricultural specialization in the Jornada region and similar patterns of architecture and material culture between the Jornada and La Junta areas in the eastern Trans-Pecos. The record also demonstrates a significant level of interaction between these and other cultural groups across the eastern Trans-Pecos region based on the wide variety of southwestern ceramic styles found in La Junta and Jornada Mogollon sites (Kelley et al. 1940; Miller and Kenmotsu 2004:238; Shackelford 1955). The evidence from southeastern New Mexico is similar and reflects a significant level of interaction between eastern Jornada settlements, Plains Village groups, and northern Toyah peoples (Kelley 1966; Simmons et al. 1989; Speth and Newlander 2012). Of particular note, one burial from the Salt Cedar site in Andrews County contained an adult male who was likely killed by four arrows tipped with Perdiz or Perdiz-like points. This find suggests that the interactions between these groups were sometimes hostile (Boyd 1997:364; Collins 1968; Prewitt 2012:193–194; Speth and Newlander 2012:175–176).

Cielo Complex and the La Junta Big Bend

Around A.D. 1000 to 1100, various Puebloan traits began to spread down the Rio Grande valley. By A.D. 1200, permanent villages had been established in the La Junta area near the confluence of the Rio Grande and Rio Conchos (Kelley et al. 1940; Kelley 1986; Miller and Kenmotsu 2004:238; Simmons et al. 1989:115). Regional prehistory includes the La Junta (A.D. 1200–1400) and Concepcion (A.D. 1400–1683) phases. The Cielo complex (A.D. 1250–1680) overlaps both of these phases. Mallouf (1999:65) defines the Cielo complex as a Late Prehistoric to Contact period aceramic entity occurring across the Big Bend region into northeastern Chihuahua and northwestern Coahuila, Mexico.

Mallouf (1999:69–73) notes that artifact assemblages attributable to the La Junta phase proper and the Cielo complex are quite similar. Lithic assemblages include Perdiz points and preforms, bifacial and beveled knives, drills, and convex end and side scrapers and a variety of expedient flake and retouched tools. Assemblages also contain occasional turquoise beads, stone and bone beads, bone tools, and *Olivella* shell beads. Unlike La Junta phase village sites where Jornada Mogollon-style ceramics occur, Cielo complex sites do not contain pottery. The latest occupation at the Cielo Bravo site includes an artifact assemblage that contains Garza arrow points, convex end scrapers, beveled knife fragments, and freshwater shell beads that may represent an influx of Plains Apache people into the region at about A.D. 1650. Mallouf (1999) discusses four competing hypotheses that question whether the Cielo complex sites represent the same or different groups as the La Junta agricultural sites and discusses their relationship to Toyah assemblages. The evidence from Cielo Bravo and other Cielo complex sites likely indicates an influx of historic Jumanos into the area by A.D. 1250 from either the Southern High Plains or northeastern Chihuahua (Mallouf 1999; Miller and Kenmotsu 2004:260). Mallouf (1999:77–78) argues that similarities in material culture and contemporaneity between Toyah phase, Cielo complex, and northeastern Mexico sites are substantial enough to support a common origin for them from a Southern High Plains bison-oriented people. Relevant to this issue is the recovery of Perdiz points from the cairn burial sites of Las Haciendas in northeastern Chihuahua (Mallouf 1987) and Rough Run in Brewster County, Texas (Cloud 2002).

Rockport Phase and Gulf Coastal Plain

The final Late Prehistoric period along the central and lower Texas Gulf coast lasted from A.D. 1250/1300 to 1700 and is identified as the Rockport phase (Ricklis 2004:172). The lithic artifact assemblage dominated by Perdiz arrow points, small unifacial end scrapers, bifacial knives, occasional beveled knives, drills, and a prismatic blade core technology, much of which is typical of central Texas Toyah assemblages, is characteristic of this period. Ceramics consist of bowls, jars, and ollas usually coated or decorated with asphaltum (Black 1986, 1989:52; Ricklis 1996:27–34). Compared to adjacent regions, Rockport phase artifact assemblages can be differentiated on the basis of distinctive ceramic associations, whereas the lithic assemblage remains much the same, except farther south where different arrow point styles prevail (Ricklis 1996:33, 2004:175). Other minor differences in the lithic assemblage are size and stem differences between Toyah and Rockport phase drills due to differences in tool blank technology.

Rockport phase subsistence clearly relied on marine resources, possibly on a seasonal basis (Ricklis 1996). Ricklis (1992, 1996:94–95) divides Rockport sites into Groups 1 and 2 and contrasts them in terms of faunal remains, artifact densities, size, seasonality, and environmental context. Group 1 sites are prairie-riverine, and Group 2 are shoreline sites; each represents a seasonal manifestation of the same cultural group. In addition to Rockport phase sites, Ricklis and others have gathered information on a series of inland sites along the Aransas River that likely represent seasonal camp sites. These differ from Rockport sites in that the ceramic assemblage is characterized by bone-tempered vessels comparable to those in classic Toyah phase sites in central Texas (Ricklis 1992, 1996:96–97, 2004:174–175). The consistent presence of Perdiz arrow points with bison bones at Rockport phase riverine (Group 2) sites argues for an occupation date of A.D. 1250/1300 or later for these sites. The presence of bison, deer, and similar lithic assemblages but different ceramic styles at locations like the Mellon site (41RF21) in Refugio County may indicate that inland and coastal groups came together seasonally to exploit bison as a cooperative effort (Ricklis 1996:96–99).

Caddo

The region east and northeast of central Texas, including portions of the Pineywoods and Post Oak Savannah, is the Caddo homeland. The chronology for this area is divided into Formative (A.D. 800–1000), Early Caddo (A.D. 1000–1200), Middle Caddo (A.D. 1200–1400), and Late Caddo (A.D. 1400–1680) periods (Perttula 2004:378). With some generalization, the Caddo may be characterized as sedentary horticulturalists with a system of social ranking (denoted by differential treatment of the deceased). Subsistence included corn, beans, and squash supplanted with an array of hunted game. Settlement was stratified among site types including small isolated farmsteads, small hamlets, and larger settlements organized around structurally distinct classes of mounds (Perttula 1992:7). The Caddo area centers on the Red and Arkansas Rivers in portions of Texas, Arkansas, Louisiana, and Oklahoma and has been subdivided into northern, western, and central subareas (Perttula 1992:7–8; Schambach 1983).

Perttula (2004:392) summarizes the exchange patterns of Caddo ceramics, noting that they were traded extensively across Texas. Early Caddo ceramic styles are common in the upper Trinity and Brazos River basins of north-central Texas and inland southeastern Texas. Later ceramic types, after about A.D. 1300, are more common in east-central and central Texas (see also Kibler 2012).

Shafer (2006) summarizes evidence for Caddo interaction with central Texas hunter-gatherer groups from about A.D. 1100 to the early Historic period. He postulates that ethnically Caddo groups occupied the prairies from the eastern edge of the Edwards Plateau eastward to the Pineywoods between A.D. 1100 and 1300, but this hypothesis is not universally accepted (Fields 2017; Gadus et al. 2006:177–181). He also documents the co-occurrence of Late Caddo ceramic types and Perdiz arrow points, hinting that there are stylistic and morphological variations among Perdiz points from such sites as McGuire's Garden (Gadus et al. 2002), 41GM281, and 41GM282 (Rogers 1995) compared to those from the Buckhollow site (Johnson 1994). He suggests that sites on the Lampasas Cut Plain and Blackland Prairie that exhibit a mixed assemblage of Toyah and Caddo artifacts should be considered as outliers of Caddo bison hunters from east Texas (see Arnn 2012a:198–199).

Toyah Identities, Arrow Points, and Social Groups

As noted, researchers have proposed several hypotheses to explain the sudden and widespread appearance of the Toyah lithic assemblage and associated bone-tempered ceramics within the classic Toyah region. Each of the proposed ideas has involved assessment and interpretation of the social identity of the makers and users and the relationships between Toyah people(s) and adjacent cultural groups.

Some interpretations have looked outside Texas, and others have focused within it; some have included multiple peoples, while others propose single groups. To say the least, our impressions of Toyah origins are multilayered and complex. Whatever Toyah was, it was significant enough to cover a large part of the state and participate in intraregional and extraregional interaction networks. Spanning the period from A.D. 1250 to 1700, about half its history falls within the period of Spanish contact (Arnn 2012a:147). As such, it rightly could be inferred that at least a portion of the answer for Toyah origins lies within the historical record. Five decades of thought on Toyah prehistory and history culminated in Arnn's (2012a:235) consideration of Toyah as a dynamic social field composed of individuals and groups participating in "multi-dimensional webs or networks" of interaction.

Arnn (2012a:235) cites the definition of a social field following Welsch and Terrell (1998:53). Social fields are social networks composed of interactions and influences. Social fields can be expansive and regional and are dynamic. They are not merely ideological or heuristic constructs for thinking about how people interact across space and time, but they represent the landscapes of daily living. The nature of interactions and relationships may vary across a social field but may have similar basic underlying tenets of adherence. Social fields can involve multiple groups, and the ways of interaction will likely vary among groups. What is apparent based on the distribution of Toyah material culture is that the various participants within the greater Toyah social field were governed by similar protocols of interaction, operation, and cooperation.

Boyd (2012:129) indicates that the classic Toyah region encompasses 51,598 square miles, 19 percent of the state of Texas. The greater Toyah area comprises some 121,622 square miles, or 45 percent of Texas, and includes Johnson's (1994) shared Toyah area. That such a large region can exhibit such a uniform lithic technology is impressive. Carpenter (2017) recently presented the concept of dual economies to discuss Toyah regional variability and social identity, suggesting that the classic Toyah toolkit represents a technology that semisedentary farmers and maritime-adapted groups from outside central Texas used during seasonal long-range bison hunting forays. Arnn's (2012a 2012b) research indicates that the classic Toyah area, by historic times, hosted a multitude of distinct groups participating in a similar economy centered on bison but exploiting a variety of other game as well. Aside from projectile point styles, the Toyah technology is in almost every way comparable to toolkits used by bison-hunting groups for several millenia on the Great Plains (Carpenter 2017:1). There is little question that bison hunting figured prominently in the design of the Toyah toolkit, despite the fact that Toyah subsistence included bison, deer, pronghorn, and a variety of other resources.

The relevance and importance of bison hunting as part of the prehistoric economy among multiple adjacent distinct cultural groups can be placed into broader perspective. Carpenter (2017) argues that the widespread presence of Toyah and Toyah-like lithic technology across a large area and its apparent adoption and use by adjacent groups (Caddo, Jumano, coastal groups, and Southern High Plains groups) may be related to a similar spread of bison-hunting technology among other semisedentary groups on the Great Plains (Drass 1998; Ritterbush 2002; Wedel

1986:98–133, 134–151; Winham and Calabrese 1998). Late Prehistoric groups in central Texas and surrounding regions were at least seasonally involved in bison hunting at A.D. 1200–1300 and 1500–1650, and Tomka (2001) notes a very consistent appearance of bifacial and beveled knives and end scrapers in lithic assemblages containing Perdiz points within west and central Texas, the Blackland Prairie, the southern coastal prairie area, and the Southern High Plains. The Toyah toolkit in full is not a common aspect of Late Prehistoric lithic technology in the Caddo region of northeast Texas, but Perdiz points occur in burial and nonburial contexts there (e.g., Dockall and Fields 2012:566–570; Shafer 1973, 1981:161). Their presence in burials at the eastern edge of the shared Toyah area may represent a symbolic use that is not evident within the classic Toyah area and maintenance of relationships with people who lived there.

While the distribution of Perdiz points in Texas is well known, few researchers have examined the distribution of this point style west into northeastern Mexico or considered what that distribution might mean in terms of a Toyah entity. Taylor (1966:81–84) describes and illustrates Nopal arrow points associated with Jora complex sites in Coahuila, Mexico, that equate to the Perdiz style in Texas. Also illustrated are arrow points that are identical to Fresno, Toyah, Garza, and Cliffton points. Perdiz points also have been reported from cairn burial sites at Las Haciendas in northeastern Chihuahua (Mallouf 1987) and Rough Run in Brewster County, Texas (Cloud 2002). Other types of arrow points associated with Perdiz points as part of the Las Haciendas cairn burial include Toyah, Fresno, Garza, and side-notched forms. A single Harrell arrow point was associated with Perdiz points in the Rough Run burial. Mallouf (1987:62) also notes morphological similarities between Perdiz points from Las Haciendas and those from collections in the Cuatros Cienegas basin to the southeast in Coahuila. Fresno, Garza, Starr, Toyah, Perdiz, and Scallorn arrow points are reported from the Laguna Mayran region of southwestern Coahuila (Heartfield 1975, 1980). Perdiz, Perdiz preforms (Cliffton), Caracara, Maud, Starr, and Toyah arrow points are reported from sites on the Rio Salado in Tamualipas, Mexico (J. Boyd 1997a, 1997b), one of these sites being considered a small workshop for the manufacture of Perdiz points. Based on this information, the western edge of the Perdiz distribution could be extended to include portions of Chihuahua, Coahuila (at least as far as the Laguna Mayran-Desierto de Charcos de Risa area and Bolson de Mapimi), Nuevo Leon, and Tamualipas. The complete Toyah tool kit inclusive of end scrapers and bifacial/beveled knives appears to be missing from these sites, however.

Arnn (2012a:40–51, 206) invokes the San and related groups of Botswana as ethnographic analog when searching for Toyah identity. The San groups occupy a region similar in size to that of the classic and shared Toyah areas. In the central Kalahari, interrelated San communities occupy distinct territories or ranges anchored along water drainages. Groups are highly mobile within their territories and possess male and female toolkits designed for a highly mobile hunting and gathering way of life. Site structure, material culture, and group organization have many correlates with the archeological record (Arnn 2012a:42; Hitchcock and Bartram 1998; Yellen 1977). Wiessner's (1983) research documents that much of the same male and female technology is shared among San groups, despite the fact that they speak three mutually unintelligible languages.

Since arrow points usually have short use lives, they normally would not be good choices to convey emblemic style (Wobst 1977), which transmits information to others about group affiliation and identity. However, San arrow points have high visibility, since they are provided to successful hunters in exchange for a claim on the meat and are important items in *hxaro* gift-giving (Lee 1979; Marshall 1976; Yellen 1977), and Wiessner's (1983) study found significant differences in shape, size, and decoration between !Kung San, !Xo San, and G/wi San points that she considers to carry emblemic information. Some of these differences, such as in stem length, blade edge angle, blade edge shape, and barb expression, would be evident archeologically, while ones relating to hafting, foreshaft construction, nocking, and fletching would not (Boscz-Zanardo et al. 2008).

In the Toyah region, Wade (2003:14, 63–64) documents the presentation of arrows and bows as peace offerings to settle disputes and grievances between historic hunter-gatherer groups in Texas and Mexico. Similarly, the presence of Perdiz arrow points in mortuary contexts in Caddo sites and as offerings in cairn burials in west Texas and northeastern Mexico could evidence the use of arrows to solemnize ceremonial occasions and maintain exchange relationships.

Historical Spanish accounts document the presence of a large number of different nations occupying the region between La Junta and the Caddo (Kenmotsu and Arnn 2012:26–37), with the Jumano, Cibolo, and Hape being commonly mentioned. All three groups were known to travel in groups much larger than kin-based groups, and the Jumano and Cibolo conducted annual movements of considerable distance. Their patterns of movement were not characteristic of groups with confined territories and limited mobility, but travel in smaller groups undoubtedly also occurred (Kenmotsu and Arnn 2012:33, 35). Wade (2003) identifies 21 Native American groups occupying the Edwards Plateau region alone during the 1670s and into the 1700s. This diversity and a similar number of social groups likely extended back into the Late Prehistoric period. Although the number of groups would have varied over time, it seems clear that a large number of self-identifying groups once occupied the Toyah region.

The point here is not to argue whether the Jumano and other groups were the originators of the Toyah toolkit, or if they adopted and dispersed the toolkit in part or in whole (see Wade 2003:220–221). The point is to demonstrate the diversity of groups occupying the region. Wade (2003:226–229) and Arnn (2012a:237–241) emphasize the importance Native group coalitions and information networks among the Protohistoric peoples in central Texas and the Edwards Plateau. Both argue carefully, however, that the Jumano cannot necessarily be equated with Toyah, but they also note that the historic range of the Jumano in the mid-to-late 1600s overlaps with the archeological distribution of Toyah material culture.

The great size of the Toyah area presents an interpretive challenge. One is confronted with the difficulty of interpreting the diversity of material culture within a framework of multiple native groups and a thick web of overlapping economic, political, and social relationships. What seems clear is the importance of Perdiz points, which represent one aspect of Toyah technology, as part of the binding that kept alliances and relationships functioning. The value of Perdiz-style points for serving this role, as compared to the rest of the Toyah toolkit (end scrapers, core and blade technology, drills, and bifacial/beveled knives), could be questioned, given the redundancy of the toolkit (minus the Perdiz point) with similar bison-oriented equipment on the Great Plains during the Late Prehistoric period. But, of all the Toyah material culture, the Perdiz point would appear to be the best candidate as a marker for social boundaries.

A possible symbolic function of Perdiz points in mortuary contexts at Caddo sites has been noted above. Shafer (2006) presents another Late Prehistoric example in which a central Texas diagnostic, Gahagan bifaces, is found in mortuary contexts in the Caddo area. Within the region of their primary manufacture, Perdiz points and Gahagan bifaces are found strictly in utilitarian contexts, but they occur in both mundane and mortuary contexts in the Caddo area. Star and Griesmer (1989) note that certain artifacts can accommodate different interpretations of meaning among different social groups, yet maintain a common identity across all social contexts. Perdiz points and Gahagan knives recovered in multiple contexts hint at multiple meanings and value ascribed to these artifacts by different groups. Both artifact types fit the requirements of boundary objects.

Boundary objects are abstract entities or physical artifacts that occupy space along the interfaces between social groups. These objects function as symbolic bridges between perceived and practical differences between social groups to establish or reinforce common understanding and cooperation (Gal et al. 2004:194). Such items are basic to the foundation and maintenance of mutual communication and cooperation and can also serve to reinforce agreements on rules of engagement between groups. They reinforce social identity within a group and between groups.

One can distinguish between primary and secondary boundary objects (Garrety and Badham 2000). Primary objects would be the technology itself—or items of technology—around which an activity is organized. Secondary objects are the other physical items or abstractions that also enable communication between social groups (ceramics, corn, mate selection, social agreements, etc.). In this case, the Perdiz point and perhaps the Toyah toolkit may have served as primary boundary objects. This impresses the importance of bison hunting as an activity that may have been negotiated among various groups, with groups in areas surrounding the fluctuating and nebulous zone of bison in the Southern High Plains, west Texas, and the Edwards Plateau deeming bison important enough to negotiate access with other groups inhabiting the area.

The regional importance of bison and the necessity of maintaining good relations and negotiating hunting rights among historic native groups in Texas have been discussed by various researchers (Ahr 1998; Arnn 2012a: 108–110; Creel 1991; Wade 2003:21, 154–157). Evidence suggests that, by the Protohistoric period, bison were one of several important negotiated resources across a vast swath of Texas. Shafer (2006) emphasizes the importance of bison to the Caddo when he speculates that Late Prehistoric sites with mixed Toyah and Caddo assemblages in the Lampasas Cut Plain and Blackland Prairie represent Caddo bison hunters from east Texas. Since it contains bison bones, typical Toyah lithic tools, and Caddo pottery and is close to the north edge of the classic Toyah area, the Jayroe site is well positioned to contribute information for helping piece together the Toyah puzzle.

REPORT ORGANIZATION

Part 1 of this report contains seven chapters, other than this introductory one, authored by Prewitt and Associates personnel. Chapter 2 describes what was accomplished during the two phases of excavation and the methods used in the fieldwork and artifact analyses. Chapter 3 presents the research design that guided the final analytical efforts and production of this report. Chapter 4 presents information on the geomorphology of the site. Chapter 5 contains descriptions of the cultural remains encountered and recovered in the excavations: the cultural features, artifacts, faunal remains, and macrobotanical remains. Chapter 6 starts by identifying how the various excavated proveniences can be grouped best for interpreting the site, i.e., analytical units, and discusses the chronology of the site. Then, it addresses various topics pertaining to site organization and the activities performed there. Chapter 7 tackles the topic of mobility and interaction in central Texas during Toyah times. Chapter 8 summarizes the project and its contributions to understanding central Texas prehistory. Part 2 contains seven chapters authored by TxDOT archeologist Jon Budd and personnel with AmaTerra Environmental, Inc. This work was done independent of the Prewitt and Associates work, prompted by different visions of what consituted appropriate analysis and reporting for the project. Twelve appendixes follow Part 2. The fist nine contain reports on a variety of special studies, along with data tables, produced by Prewitt and Associates. The last three were produced as part of the TxDOT/AmaTerra effort.

CHAPTER 2: WORK ACCOMPLISHED AND METHODS OF INVESTIGATION

The Jayroe site was first identified during survey of new right of way for the proposed bridge replacement on County Road 294 in November 2003. That survey consisted of excavation of three backhoe trenches, one on the T_{1b} surface and two on the T_{1a} surface (Broehm et al. 2004:2–5). Cultural materials were found in both trenches on the T_{1a} surface but not in the trench on the T_{1b} surface. The trenches showed that the stratigraphy of these two landforms differed, with the deposits below the lower T_{1b} surface being a more-recent alluvium inset to and draped over a paleosol formed in late Holocene alluvium below the T_{1a} surface. The cultural materials rested on and in the paleosol.

The site appeared to cover an area of at least ca. 2,520 m^2 within the new right of way and to extend an unknown distance outside the right of way. Cultural materials observed consisted of chert debitage, burned rocks, charcoal, and freshwater mussel shells. No diagnostic artifacts or intact features were observed, however, the paleosol was identical to that observed at 41HM46 across the river, which yielded a Late Archaic Ensor dart point (Dockall et al. 2011). The paleosol was considered comparable to the Leon River paleosol identified in a similar geologic and geomorphic context downstream at Fort Hood. Because of this, it was determined that the cultural materials at 41HM51 most likely represented occupations during the Late Archaic and Late Prehistoric (Austin phase) periods.

Because the site contained well-preserved, buried archeological remains with the potential for discrete assemblages, it was considered potentially eligible for listing in the National Register of Historic Places and designation as a State Antiquities Landmark (Broehm et al. 2004:4–5). Test excavations to more fully assess it were recommended.

TEST EXCAVATIONS

The test excavations were done in December 2003 and January 2004 (Broehm et al. 2004). Backhoe trenches were to be excavated across the T_{1a} surface to the top of the paleosol. Test unit excavation would then begin at the surface of the paleosol and terminate at 1.0 m below the top of it. The original testing plan called for hand excavation of 10 m^3, with the possibility of an additional 5 m^3 depending on the productivity of the initial units.

Four trenches (4–7) and eleven 1x1-m test units were excavated during the initial phase of testing (Figure 2.1). Trench 4 was the southernmost, ca. 12 m north of the scarp separating the T_{1a} and T_{1b} terrace surfaces. It was just south of Trench 2 excavated during survey. Oriented east-west, it measured 8.2 m long, 2.5 m wide, and 0.8–1.0 m deep. Trenches 5 and 6 were just south of the middle of the site, the former near the west side of the proposed right of way and the latter near the east side. Trench 5 was oriented east-west and measured 7.1 m long, 2.4 m wide, and 0.8–0.9 m deep. Oriented north-south, Trench 6 measured 5.7 m long, 3.1 m wide, and 0.7 m deep. Trench 7 was the northernmost of the initial trenches, approximately 36 m south of the north edge of the right of way. Oriented north-south, it measured 7.9 m long, 2.6 m wide, and 1.3–1.4 m deep. Two contiguous test units were excavated in Trenches 5 and 6, 3 in Trench 4, and ultimately 4 in Trench 7. Nine units (Test Units 1–6 and 8–10) extended to 1.0 m below the top of the paleosol, and 2 (Test Units 7 and 11) were dug to 0.5 m. Artifact recovery was extremely low in Trenches 4–6. Trench 7 contained more artifacts, and the test units there exposed three cultural features: a pit filled with burned rocks and charcoal, an ash-filled pit, and a small cluster of burned rocks.

Based on that recovery, TxDOT authorized the excavation of the additional 5 m^3. These additional excavations focused on the northern part of the site, as recovery in the southern part was extremely low. Also, because artifacts were particularly sparse in the lower 0.5 m of each test unit, the additional hand excavations generally went only 0.5 m deep. The new test units were placed in Trenches 8 and 9. Trench 8 was just north of Trench 7. Oriented north-south, it measured 7.3 m long, 3.4 m wide, and 1.3 m deep. Trench 9 was placed 11 m east of Trenches 7 and 8 near the eastern edge of the proposed right of way. Oriented northwest-southeast, it measured 6.0 m long, 3.2 m wide, and 1.6 m deep. Two test units were placed in Trench 8 and six forming a 2x3-m block in Trench 9. One unit in each of these new trenches was excavated to 1.0 m below the surface of the paleosol (Test Units 13 and 15), and the remainder were excavated to 0.5 m. The methodology for excavation of these trenches was the same as in the first phase of testing, i.e., mechanical excavation to the top of the paleosol with hand excavation below that (Figure 2.2). Fortuitously, excavation of Trench 9 ceased 20 cm above the paleosol, as it had partially in Trench 7. The significance of this was not realized initially, but this occurrence allowed the Toyah component, which up to then had not been fully recognized, to be identified and assessed.

Excavation of each test unit proceeded in 10-cm levels. A datum was placed at the highest corner of the unit, and each level was measured from a level line originating at that point. In this way, elevations were taken from near the top of the paleosol. All sediment was screened through 1/4-inch-mesh hardware cloth. Soil descriptions, artifacts collected or observed, disturbances, and other features of interest were recorded on a standard form for each level of each unit. Artifacts collected were bagged separately by level and unit and returned to the Prewitt and Associates, Inc., lab for processing. Counts of collected artifacts were made at the time of excavation to monitor artifact frequencies and distributions. Burned rocks were counted and weighed in the field and then discarded. A map depicting the locations of trenches and test units was made using a Sokkia SET 5F total station. The excavations were documented with 35-mm color and black-and-white images;

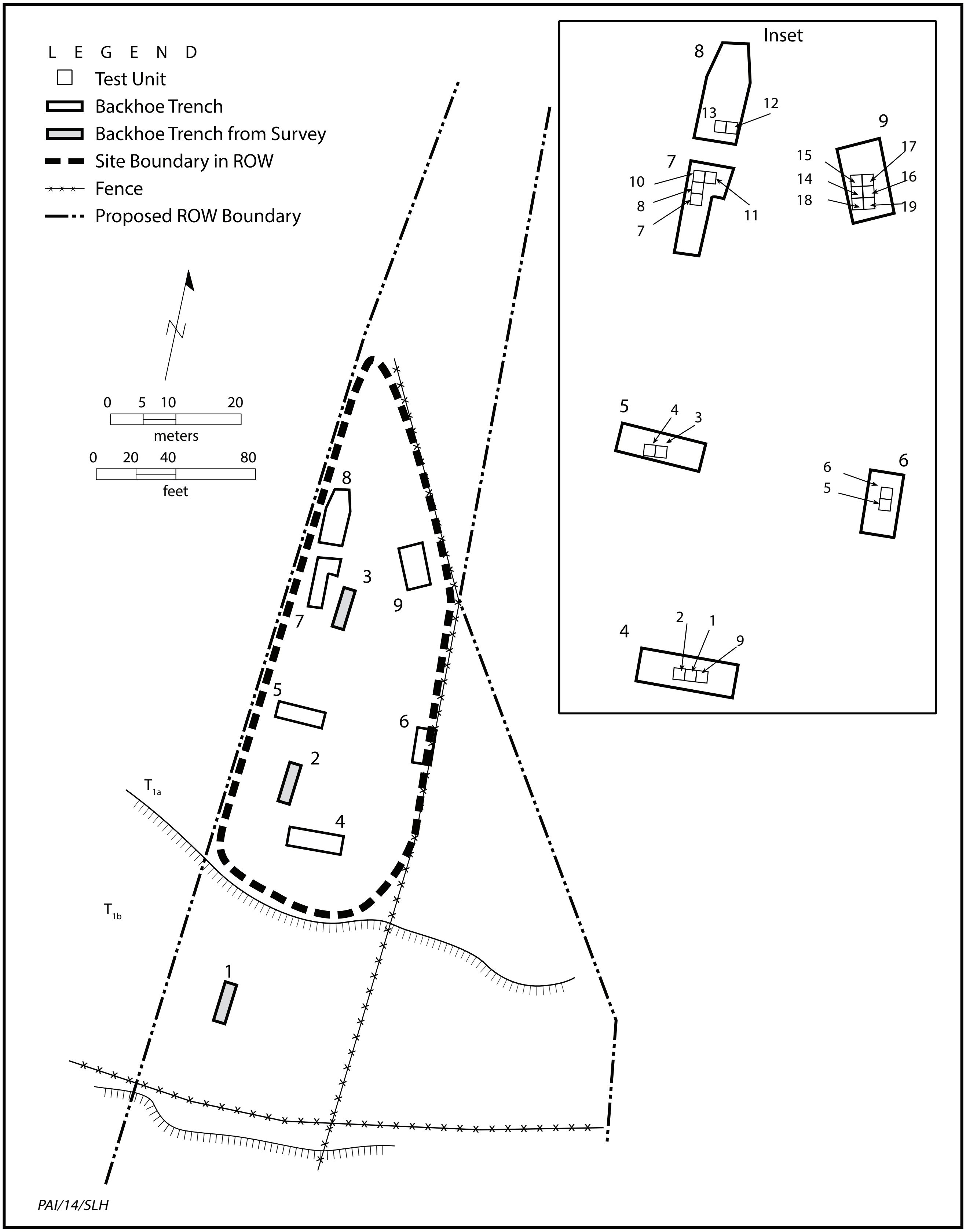


Figure 2.1. Plan of 41HM51 showing the test excavations. Site locations are not shown in report copies for public distribution.

a

b

Figure 2.2. Photographs of the test excavations in progress. (a) View to the east of machine removal of the upper alluvial unit in Trench 4 (note dark paleosol in trench bottom); (b) view to the west of the upper parts of Test Units 3 and 4 dug into the paleosol in the bottom of Trench 5.

the color slides ultimately were scanned to create digital images for curation, and the original field photographs were discarded.

The cultural remains collected or observed during testing were as follows: 1 Ensor dart point, 3 Perdiz arrow points, 1 possible Perdiz point, 1 unidentified arrow point fragment, 7 bifaces, 1 uniface, 1 core, 3 edge-modified flakes, 1 ground stone tool, 2 modified bones, 1 piece of cut mussel shell, 5 ceramic sherds, 299 pieces of lithic debitage, 388 freshwater mussel shell umbos, and over 486 pieces of bone weighing 637.6 g. In addition, 723 burned limestone rocks (and a few burned sandstone rocks) weighing over 28.1 kg were counted in the field. Burned clay, weighing 47.3 g, was collected, and more was observed during excavations but could not be collected or otherwise quantified due to its poor condition. One piece of ochre was also collected.

The lithic assemblage was unremarkable, consisting of mostly crude tools and small to medium-sized chert flakes representing mid- and later stage tool manufacture and possibly some lithic tool maintenance. The prehistoric ceramics all appeared to be from the same vessel and of the same type: Bullard Brushed, a Late Caddo type that occurs mainly in the area of the Neches and Sabine Rivers and is known from central Texas as a trade ware. Vertebrate faunal remains seemed to represent mainly small and medium-sized vertebrates, with turtles, rodents, deer, and bison observed.

Seven cultural features were identified (see Chapter 5, Table 5.1). Only one, Feature 3, a cluster of burned limestone rocks possibly representing a dump, was recorded at the southern end of the site in Trench 4. Its base was 15–20 cm below the paleosol surface. Of the remaining features, all in Trenches 7 and 9, three appeared to be associated with the interface of the paleosol with the overlying recent alluvium, and three were beneath this interface. Feature 7 was a cluster of freshwater mussel shells ca. 80 cm below the top of the buried soil with some associated burned limestone rocks as well as negligible numbers of bones and a flake. While no diagnostic materials were directly found in this feature, an Ensor dart point was stratigraphically associated, suggesting a Late Archaic occupation. Features 5 and 6 were also beneath the paleosol surface, but only shallowly so (21 and 29 cm). They consisted of a cluster of burned limestone rocks probably representing a dump and a pit filled with burned rocks and charcoal.

The remaining three features were at the paleosol surface. These consisted of an ash pit, (Feature 4 in Trench 7) and a rock- and charcoal-filled pit and a small shallow possible pit with occasional pieces of charcoal and burned clay (Features 8 and 9 in Trench 9). One temporally diagnostic artifact was recovered from Feature 8: a prehistoric ceramic sherd from the Bullard Brushed jar that the remaining four ceramic sherds found belonged to.

The cultural remains at 41HM51 clearly represented two different periods of occupation. The predominant one was associated with the top of the paleosol. Most of the artifacts recovered were from this interface. For example, 87 percent of the lithic debitage and 69 percent of the bones were from the upper 30 cm of the test units, corresponding to the contact between the upper and lower alluvial units. All 5 ceramics, 7 of 11 lithic tools, the core, the ground stone tool, 1 modified bone, the modified shell, and 4 (of 5) arrow points also came from the upper three levels. A Late Prehistoric Toyah phase association for these materials was shown by the Perdiz arrow points, Late Caddo ceramics, and radiocarbon dates from features. Test excavations suggested that this component was centered in the northern part of the project area.

The second cultural zone was recorded at ca. 70–90 cm below the surface of the paleosol. It was observed mainly as a peak in artifact recovery in these levels and by Feature 7, a mussel shell concentration. Two bifaces and a modified bone were also associated. An Ensor dart point from this stratum suggested a Late Archaic occupation, with corroborating evidence coming from 41HM46 just across the river.

Radiocarbon dating was performed on five wood charcoal samples from four of these features, all from the paleosol surface (see Chapter 6, Table 6.2). The two-sigma date ranges, between A.D. 1300 and 1660, indicated occupation during the Toyah phase of the Late Prehistoric period. The Caddo sherds and Perdiz points (and another unidentified arrow point) found at the paleosol surface were all in agreement with this temporal assessment.

The test excavations showed 41HM51 was an open campsite that consisted of two identifiable components: a Late Prehistoric Toyah phase occupation at the interface between the buried soil and the overlying recent alluvial drape and a terminal Late Archaic occupation buried 70 to 90 cm into the paleosol. The Late Prehistoric component was judged to have the capacity to produce data that could answer questions of importance regarding Texas prehistory, including intrasite patterning and the delineation of activity areas, subsistence and economic activities, and interregional contact and interactions, and the site was recommended as being eligible for listing in the National Register of Historic Places and designation as a State Antiquities Landmark. Data recovery excavations focusing on the later component were considered warranted if adverse impacts from the construction of the new bridge could not be avoided (Broehm et al. 2004:35–36). The Texas Historical Commission and TxDOT concurred with these recommendations, leading to development of plans for data recovery investigations.

DATA RECOVERY INVESTIGATIONS

The scope of work for data recovery specified excavation of contiguous 1x1-m units totaling 60 m^3 in volume in the form of one or more excavation blocks. The initial block was to be centered between Trenches 7 and 9. Block areas would be machine stripped to within 20 or 30 cm above the paleosol surface so as to leave the Toyah component intact. Depths of the top of the paleosol in the northern part of the site were known to vary from 110 cm to just over 200 cm below the modern ground surface. The size and configuration of the block(s) was not set, but it was projected at least 120 units (averaging 50 cm deep) would be excavated. The final size and shape of the block(s) would be dictated by field assessments of artifact and feature recovery. From the machine-stripped surface at 20–30 cm above the paleosol, each unit was to be excavated to a depth of at least 40 and not more than 60 cm, so at least the interface and one full level of paleosol would be excavated.

Data recovery investigations began on April 26, 2004, and ended on July 16, 2004. Excavations eventually consisted of machine excavation of ca. 256 m^2 to within 30 cm of the top of the paleosol, excavation of two backhoe trenches south of the block to within roughly 20 cm of the top of the paleosol, and hand excavation of 60.1 m^3 in the form of 155 units measuring 1x1 m. A total of 153 (59.2 m^3) of these units were in a contiguous block placed in the large stripped area. The remaining 2 (0.9 m^3) were in the two backhoe trenches excavated south of the stripped area and main block excavation (Figure 2.3).

Machine stripping of the block began on April 27 and continued through April 30 (Figure 2.4a). In its initial configuration, the stripped area was roughly rectangular and overlaid the eastern edges of Trenches 7 and 8 and the very northwest corner of Trench 9. It measured ca. 10 m east-west and 24 m north-south. The southwest corner of Trench 9 was later exposed during manual excavations in the southeast corner of the stripped area.

The logistics of machine stripping presented some problems. The northern part of the project area narrows, which made use of heavy equipment challenging. In particular, the need to place and remove backdirt hindered excavation too close to either the eastern or western edges of the right of way. In addition, the machine could not maneuver close to the eastern edge due to the trees growing there. Most importantly, the depth to the paleosol surface below the modern ground surface was not clearly known, and the information from test excavations showed it fluctuated significantly, with depths between 110 and 200 cm and a general trend toward decreasing depth to the south. Informal shovel and auger probes during the initial stripping confirmed this. Additional shovel and auger probes were dug throughout the stripping to estimate the depth to the paleosol surface. These were spaced far enough apart and of small enough size to avoid damaging the archeological materials. The paleosol's surface in the northern part of the block was particularly difficult to identify. A bed of dark clay similar in color and texture to the paleosol capped the soil here, as opposed to the interbedded light brown alluvial sand and brown mud that typically buried the paleosol across the rest of the site. Because of this uncertainty, the northern part of the block was left high for a time, although the backhoe was later used to remove the remaining overburden after excavations in the block had commenced and the crew had a better handle on the paleosol/clay interface. In no part of the block did machine stripping impact the paleosol surface. In many areas, the overlying alluvium was more than 30 cm thick after stripping. In these cases, additional overburden had to be removed by hand as the backhoe could not strip it off without disturbing the underlying cultural deposit.

Hand excavations began on May 3. An initial block of 22 units (Excavation Units 1–22) measuring 11x2 m was placed near the center of the machine-stripped area at its south end, directly between Trenches 7 and 9 (Figure 2.4b). Excavation units (and the excavation block as a whole) were oriented to approximately magnetic north. Artifact and feature recovery from these first 22 units provided the basis for placement of additional units. The excavation block expanded (generally with small blocks of units opened up) in all directions from these first 22 units, eventually growing to 153 units covering an area up to 13 m wide and 21 m long (Figure 2.5).

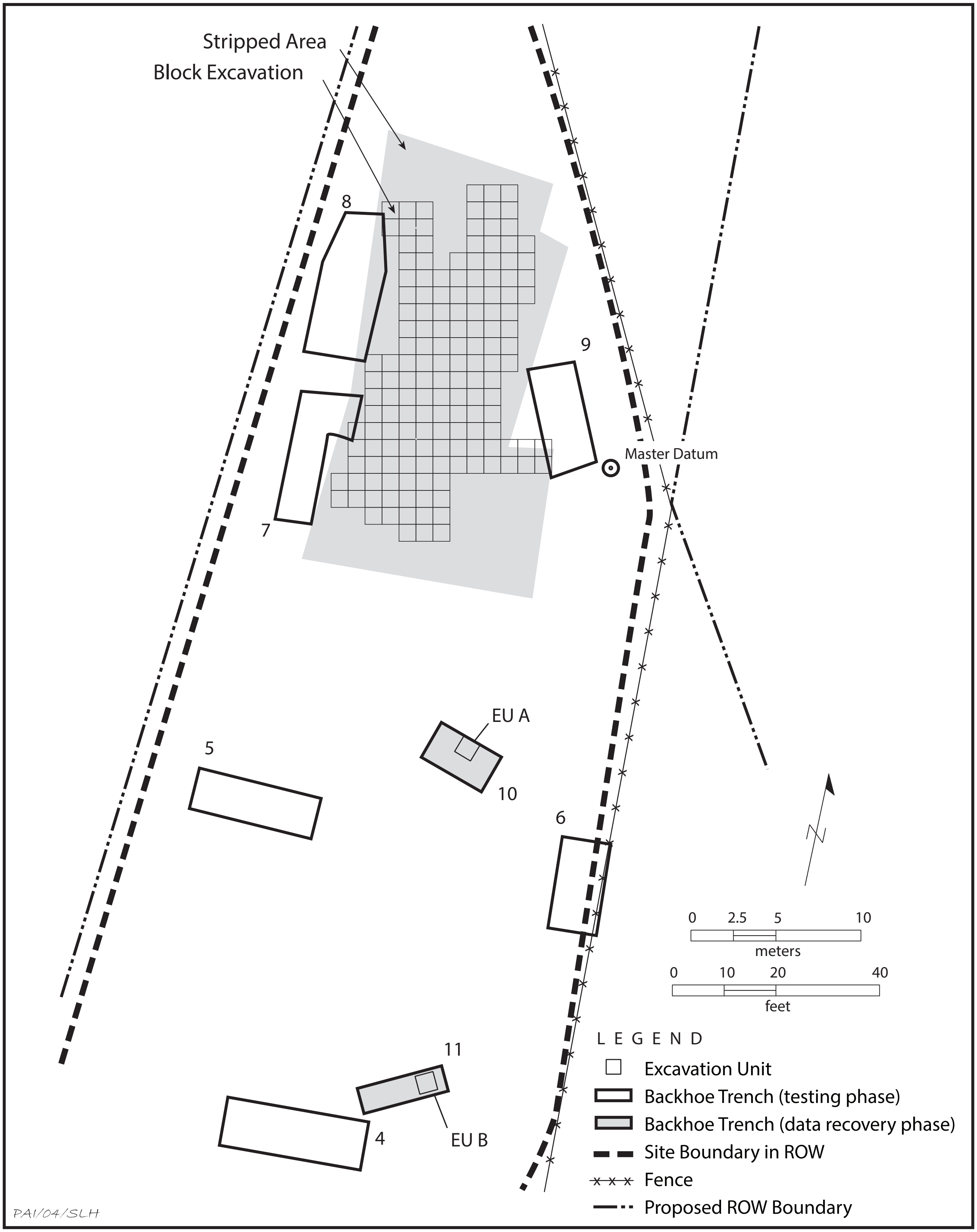


Figure 2.3. Plan of 41HM51 showing location of data recovery excavation block and backhoe trenches. Site locations are not shown in report copies for public distribution.

a

b

Figure 2.4. Photographs of the data recovery excavations in progress. (a) View to the south of initial machine stripping; (b) view to the northwest of initial hand excavations.

Units were numbered consecutively beginning with "1." Unit numbers thus assigned were 1–116, 119–120, and 123–157. Numbers not used were assigned to units that, in the end, were not excavated.

Midway through the excavations, two trenches were excavated well south of the block area to recover additional information about the extent of the Toyah component (see Figure 2.3). Trench 11 was near Trench 4, the southernmost testing trench near the edge of the T_{1a} terrace, and Trench 10 was halfway between the data recovery excavation block and Trench 11. Machine excavation in these trenches stopped 20 cm above the paleosol. One 1x1-m unit (Excavation Units A and B in Trenches 10 and 11, respectively) was placed in each of these trenches. Both units contained artifacts just above and below the top of the paleosol, indicating that the Toyah component extends south toward the river, but artifact densities there are lower than they are in the block excavation overall.

All hand excavations were done in 10-cm levels. Elevations were keyed to a single datum at ground surface placed at the southeast corner of Trench 9 that was given the arbitrary elevation of 100.00 m. This datum had been established during test excavations. Elevations in each unit were measured and recorded using a Pro Shot L2+ laser level. Depths of excavation units varied from 20 to 60 cm (average = 39 cm). Some were as shallow as two or three levels due to a combination of too much overburden having been removed prior to hand excavation and low artifact recovery. In all cases, however, the paleosol interface and one level of the paleosol were excavated. All soil was dry screened through 1/4-inch-mesh hardware cloth. Soil descriptions, artifacts collected or observed, disturbances, and other features of interest were recorded in writing or by illustration on a standard form for each level of each unit. The excavations were documented with 35-mm color and black-and-white images; the color slides ultimately were scanned to create digital images for curation, and the original field photographs were discarded.

Artifacts collected were bagged separately by level and unit and returned to the lab for processing. Counts of collected artifacts were recorded on a separate form at the time of excavation to monitor artifact frequencies and distributions and guide expansion of the excavation block. Burned rocks were counted and weighed in the field and then discarded. Complete *Rabdotus* sp. specimens were also counted in the field and not collected. Several charcoal samples were taken from nonfeature contexts for radiocarbon dating.

Nine features were recorded. They were documented in plan and cross section where appropriate. All relevant information was recorded on a standardized feature form. Burned rocks were size graded, weighed, and quantified. If possible, all fill was collected for flotation and the recovery of macrobotanical and other remains. Charcoal samples for radiocarbon dating were also taken where possible. A map depicting the locations of backhoe trenches, the machine-stripped area, and the excavation block was made using a Sokkia SET 5F total station.

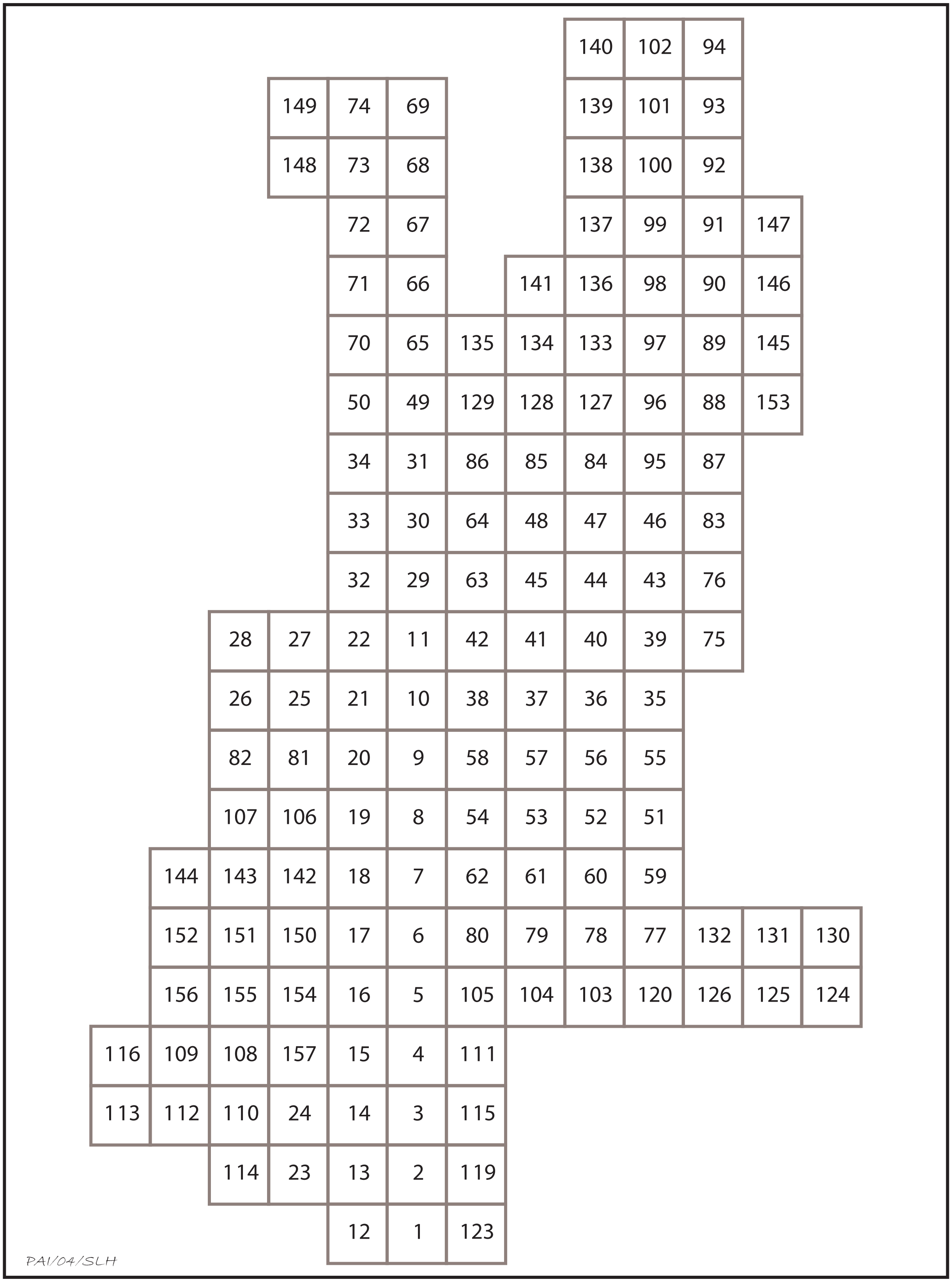


Figure 2.5. Plan of data recovery excavation block showing excavation unit numbering.

ANALYSIS METHODS

Lithics

The methodology for analysis and interpretation of the stone artifacts is guided primarily by the TxDOT Chipped Stone Analytical Protocol (Version 2.4b) and the research design developed for this project. The analytical procedures rely on standardizing taxonomy and distinguishing between tools and nontools and core-derived versus core-based tools. This type of dichotomous framework is intended to provide a relatively stable and standardized method of sorting assemblages into meaningful categories of artifacts (cores, tools, and nontool debris). See Dockall (2014) for more details regarding the application of the TxDOT Chipped Stone Analytical Protocol.

Once the observations on the tools, cores, and unmodified debitage were made and the data were entered into the appropriate spreadsheets, analysis involved classifying the assemblage into the following categories: projectile points, bifaces, unifaces, expedient flake tools, utilized flakes, cores, and unmodified debitage. The analysis methods used are briefly discussed below. The analysis is predicated on the understanding of lithic technology as a continuum from the procurement of raw material through manufacture, rejuvenation, and eventual discard (Bradley 1975; Collins 1975; Holmes 1894; Muto 1971).

Tools

Chipped stone tools were sorted into projectile points and preforms; bifaces; unifaces; drills, perforators, and gravers; flake and blade tools; and chopping tools. Measurements taken, where possible, include maximum length, maximum width, maximum thickness, weight (grams), and edge angle, with some additional measures for projectile points (see below). Dimensions were not projected or estimated for broken tools. Edge angle for tools was recorded as an averaged measure along the used/modified portion(s) of the tool. Edge angle measurements were taken with a goniometer. Metric information for all tools is presented in Appendix I.

An assessment of the state or stage that a tool had reached in its use life was determined from technological analysis, use wear, and fracture patterns. Stage of manufacture was recorded for all tool groups with the assumption that all tools proceed along a generally linear trajectory from manufacture to discard. This theoretical construct provides the analyst with the means necessary to place the lithic assemblage in a behavioral and functional perspective. The theory behind the linear reduction process is based on previous archeological and experimental studies (Callahan 1979; Collins 1975; Crabtree 1966; Muto 1971; Shafer 1973; Young and Bonnichsen 1984). The protocol also follows closely the manufacture stage scheme discussed by Black, Miller, et al. (1997:455–457).

The stages used in this analysis are expanded slightly from the five stages in the analytical protocol but conform to the intent. Seven stages of reduction are defined: initial reduction, early-stage forming, late-stage preform, finished product, recycled, rejuvenated/repaired, and indeterminate. The rejuvenated/repaired and indeterminate stages were added to make it easier to categorize some nonbifacial tools.

The first stage, initial reduction, represents the beginning of the manufacturing process and can include the production of flakes or blades for tools or the initial thinning and shaping process for bifaces. For bifaces, the tool form is usually irregular in shape and is equivalent to Stage 1 of other studies (e.g., Dial and Collins 1998:539–543). Bifaces and flake/blade tools in this stage of manufacture can retain large areas of cortex, and size can vary according to the tool blank. In this analysis, the majority of nonbifacial tools are attributed to this stage of the manufacturing process, unless there are other indications of later-stage reduction, recycling, or rejuvenation/repair. If nonbifacial tools were deemed to have been recycled or otherwise repaired/rejuvenated, then it was possible for them to have transitioned from initial reduction to one of the final two stages in the use history of the artifact. The same rationale holds true for bifacial artifacts. For example, a middle- or late-stage biface fragment that had been subjected to a deliberate radial or snap break and then subsequently used as a scraping implement or burin would be classified as recycled or rejuvenated/repaired and not as middle- or late-stage forming. Examples of these types of artifacts were identified in this assemblage, which underscores the need for careful technological analysis and understanding of manufacture- versus use-related breakage.

Early-stage forming or blank preparation applies to middle-stage bifaces that are equivalent to Stage 2 or 3 bifaces, which are characterized by continued thinning and shaping so that it is difficult to determine the original flake or blank attributes. Little cortex may remain, and the artifact morphology is more refined and regularized in outline. A mix of hard-hammer and soft-hammer percussion techniques may be apparent on artifact surfaces. At this stage, hafting elements may also be apparent.

Late-stage preforms have more-refined artifact outlines, advanced shaping and thinning, and typically no cortex. Preforms have a significant reduction in thickness over their earlier stages. Stems or other haft elements may be essentially complete. Often, all that is lacking is the final shaping of the lateral edges of the biface blade or haft. Technology may still include use of both hard- and soft-hammer percussion to achieve a refined artifact outline. Previous studies that have included multiple biface manufacture stages would assign these artifacts to Stage 3 or 4 depending on the number of stages employed by the analyst (Black, Miller, et al. 1997; Dial and Collins 1998:545–548). Young and Bonnichsen (1984:76–82) suggest that this stage of manufacture focuses on shaping and thinning of the form, whereas earlier manufacture efforts are on edge or platform preparation and shaping. At this stage, such techniques as pressure flaking and notching are also conducted.

The finished product stage was used in lieu of final edge trimming and shaping as suggested in Version 2.4b of the TxDOT protocol. Generally, this stage includes finished artifacts or those very close to completion in terms of manufacture prior to use. At this stage, bifacial and other artifacts have been refined in outline shape and overall morphology except for terminal shaping by such techniques as pressure flaking or indirect (punch) flaking. Notching and other haft element aspects are complete.

The final two stages, recycled and rejuvenated/repaired, are best discussed together even though they involve very different technological choices on the part of the tool maker/user. The TxDOT protocol makes no real distinction between recycling and rejuvenation and considers them roughly equivalent in meaning. For this analysis, and in accordance with a portion of the research design for this project, a distinction is made between them.

Rejuvenation implies restoration of function to an otherwise broken or worn implement. In this case, the restored function is the same as the original function of the tool. Technological indicators of rejuvenation or repair would include beveled edges on bifacial knives or projectile points, reworked blade edges on projectile points, or unifaces displaying indications of resharpening. Indirectly this would be represented by the presence of uniface or biface resharpening flakes as part of the unmodified debitage assemblage.

Recycling implies refurbishment or alteration of a tool for a different function or as a source of material to make other tools. In the assemblage from 41HM51, numerous instances of recycling are identified. These include bifaces and unifaces that display deliberate radial or transverse breaks, the presence of use wear on radial or transverse break fracture edges, implements repurposed for other tasks, cores reused as hammerstones, and the like. Similar distinctions have been made by other researchers (Amick 2007). Recycling and rejuvenation do not necessarily occur only when raw material is scarce or of unknown supply. According to Amick (2007), such strategies can be the result of opportunistic behavior, mobility constraints, restrictions to raw material access, or how the lithic technology is organized. Both can be a regular component and technological option to stone technologies.

All chipped stone tools (and cores and debitage too) were examined under ultraviolet light to distinguish Edwards cherts from other cherts. The ultraviolet study (UVF) provided more useful baseline information on the geological origins of artifacts and debris than would have been available otherwise. The technique is simple, expedient, and inexpensive for distinguishing quickly between different lithic sources that are often visually similar (Frederick et al. 1994; Hillsman 1992; Hofman et al. 1991; Newlander and Speth 2009). All UVF analysis was conducted by a single analyst to eliminate inter-observer errors. Analysis was done with a Raytech LS-4 lamp in a darkened room following methods used by Newlander and Speth (2009:48). The analyst used an arbitrary standard distance of 5 cm from the UV source to the observed sample. All samples and artifacts were examined under both long- and short-wave UV, but color determinations were recorded only for the latter. Additional details on type collection samples and regional differences in chert color fluorescence are provided in Chapter 5.

PROJECTILE POINTS

Dart and arrow points are a functional group that is inclusive of all artifacts used to tip projectiles or other similar weapons. Typically, they are characterized as bifacial (but sometimes unifacial) flaked tools with triangular to leaf-shaped blade sections, pointed distal ends, converging tips, and uniform lateral blade edges. Distinctions between dart and arrow points are based on size. Where possible, projectile points were assigned to established formal types. Specimens that cannot be assigned to a named type are classified as untyped. Fragments that cannot be classified because they are too incomplete are classified as untypeable. Completeness, breakage type, and raw material were noted for each specimen. Stem length, stem width, neck width, neck thickness, and basal width were recorded, along with other standard measurements.

BIFACES

Bifaces and bifacial artifacts were classified according to technological assessments of manufacture stage, breakage type, and tool type. Completeness and raw material type were also noted. Unfinished bifaces were classified as Stage 1, 2, 3, or 4, and finished functional bifacial tools were classified by tool type. Tool type categories consist of knife, beveled knife, fragments with burin retouch, and indeterminate fragments. The characteristics and technological attributes of different stages of bifaces are described in further detail in the TxDOT lithic protocol.

Stages 1 through 4 reflect the technological changes that occur from the following: procurement and initial reduction (Stage 1); blank shaping, preform shaping, and thinning (Stages 2 and 3); and final edge trimming and shaping (Stage 4). Stage 5 is reserved for those bifaces and fragments that represent resharpened, rejuvenated, or recycled implements. Each stage transitions to the next with subtle to well-defined changes in percussion techniques, platform preparation, edge sinuosity, and thinning, although this general sequence can vary among biface types.

UNIFACIAL TOOLS

Unifaces were classified according to technological aspects and given names generally indicative of function and morphology. These tools include convex end unifaces manufactured from blades or blade-like flakes and percussion flakes, end/side scrapers, side scrapers, beaked unifaces, and spokeshaves. Tools identified as scrapers have at least one edge altered by direct percussion retouch. These tools have edge retouch that is regular and somewhat invasive and could be continuous or localized to a tool margin. Most have at least one edge modified or altered by some type of direct percussion. Completeness, breakage type, and raw material types were noted for these tools.

FLAKE AND BLADE TOOLS

Edge-modified flake tools are flakes or flake fragments that display edge modification resulting from tool use such as cutting or scraping; they may or may not have deliberate edge retouch or modification. These tools are identified based upon the presence of unifacial, bifacial, or other microwear and any associated retouch. Implements in this group were classified according to function as determined from microscopic and macroscopic use wear analysis. Represented tool types include unmodified and modified flakes and blades and radial- or snap-break tools/fragments. These types of tools were employed primarily as expedient cutting and scraping implements and are treated separately from unifacial tools with defined forms.

Cores

Cores are angular lithic chunks with evidence of single or multiple flake removals. Analysis of these artifacts is not addressed in the protocol. Cores were assigned to a specific group and type. For each artifact, presence/absence of thermal alteration, flake removal pattern, and type of platform preparation were also recorded. Maximum length, maximum width, maximum thickness, and weight (grams) were recorded. Core types identified include blade cores and fragments, discoid or bifacial cores, and macroflake and microflake cores and other core fragments.

Unmodified Debitage

All debitage was size graded following the TxDOT Chipped Stone Tool Analytical Protocol (Version 2.4b, March 6, 2013) as follows: Grade 1 = 1.0 inch or larger; Grade 2 = 1.0–0.75 inch; Grade 3 = 0.75–0.5 inch; Grade 4 = 0.5–0.25 inch; and Grade 5 = less than 0.25 inch; Grade 5 also includes microdebitage recovered by water screening samples from feature contexts. Each lot of debitage was passed through a series of nested screens, segregated, counted, and weighed. Cortex was recorded as present or absent rather than based on percentage estimates, since the assemblage has few cortical pieces. Thermal damage and heat treatment were recorded as well. Flake type, platform type, and other technological attributes were not recorded.

Size grade data can be used to address the composition of an assemblage and the array of techniques and trajectories of core reduction and tool production represented (see Ahler 1989a, 1989b; Henry et al. 1976). There are a number of limitations to using mass analysis to interpret core reduction and sequences of tool manufacture, however. Andrefsky (2009) summarizes these limitations. The principle problems involve mixed assemblages representing different production techniques. Another problem concerns the effects of mixed core reduction trajectories and assessing core reduction intensity. The 41HM51 assemblage includes debitage contributed from general percussion cores, bifacial or radial cores, blade or flake blade cores, and tool manufacture and maintenance. No attempt was made to control for the effects of each trajectory on the size grade data.

Cortex abundance is often used as supporting information to determine the degree of lithic reduction that has taken place at a site or in association with different types of reduction or manufacture trajectories. Researchers have usually found cortex useful only for determining the ends of a core reduction or tool manufacturing sequence (Odell 2004:127). Cortex amount covaries with the size and shape of the initial raw material (Andrefsky 2001:12). Categories based on assessing proportions of dorsal cortex were avoided for several reasons, including inconsistency in measurement, lack of standardization, and its limitation to only complete flakes (Bradbury and Carr 1995:101). Observing only presence or absence allows the analyst to include flake fragments and shatter pieces bearing cortex without the need for reduction stage inferences. Type or character of cortex was recorded as chalky (weathered or unweathered), streamworn, patina, or absent. This relatively simple scheme is both easily replicable and informative of probable procurement environment. Type and color of exterior staining were not considered as important as the basic characteristics of the cortex. The presence and type of cortex are significant for cobble and pebble forms of raw material, but raw material procured from bedrock sources as ledge material naturally has little cortex. The patterns that can be observed in cortex also vary with how the technology was organized. For instance, cortex could be significant at lithic procurement sites where material testing, core shaping, and early stages of biface manufacture occurred, but would be of little importance at sites dominated by late-stage biface manufacture, maintenance, and discard of formal tools.

The presence of deliberate heat treatment and incidental thermal damage was recorded to document the preponderance of these types of secondary alteration. Heat treatment was identified by the presence of a luster difference, reddening, or a combination of these, and incidental thermal damage was recognized by crazing, cracking, and pot lid scars. Heat treatment associated with particular types of flakes or certain types of finished or unfinished artifacts would be informative as to how this technique was employed in the manufacturing process and at what stage(s) of manufacture it was applied. The amount of incidental thermal damage provides some important taphonomic data on the lithic assemblage as a whole and the impact of the presence of thermal features like hearths on the postdepositional history of the artifacts. It also may be important in understanding discard patterns adjacent to such features.

Ceramics

Forty-three ceramic vessel sherds were recovered during the testing and data recovery excavations. These sherds represent a minimum of three vessels, based on color, decoration, vessel form, temper, and refitted sherds. They were analyzed for descriptive purposes and to understand vessel usage at the site. In addition, a sample of sherds was selected for instrumental neutron activation analysis (INAA) and petrographic analysis aimed at distinguishing local from nonlocal vessels and thus elucidate interregional interaction between vessel manufacturers and vessel users.

The characteristics recorded for each sherd are based on those important in determining the manufacturing process and function of a vessel as defined by Rice (1987). Sherd size was recorded as the weight of each sherd in grams and its thickness measured in millimeters. The exterior and core colors of the sherd paste were recorded as black (10YR 2/1), gray (10YR 5/1), dark grayish brown (10YR 5/6), or yellowish brown (10YR 5/6). Paste temper was recorded as grog and grog-bone, these being the only temper types noted. Temper was distinguished on a fresh break using a 10x hand lens. The vessel portion represented by each sherd was recorded as rim, base, neck, body, or indeterminate. Rim form was further recorded as everted, inverted, or straight, while the rim lip forms include tapered and rounded examples. Base form was recorded as flat or indeterminate. Vessel portion characteristics help the analyst determine the vessel forms represented, which provides clues as to the function of the vessel. To this end, interior and exterior surface treatments were recorded along with surface modification.

Surface treatment is the method used to finish a vessel surface and includes burnishing, floating, smoothing, slipping, scraping, or texturing. Different finishes can provide clues as to vessel use. For example, burnishing helps to form less-permeable surfaces, which may be beneficial in the cooking and storage of liquids, while exterior texturing may provide for secure handling of large heavy vessels (Rice 1987:138, 231). Surface modification occurs after the vessel is put into use and includes, in this sample, burned encrustations on exterior and interior surfaces. The size of these vessels is estimated based on rim and neck thickness, as vessel sections analyzed were not large enough to provide data on vessel diameter or height.

Both the vessel forms suggested by sherd characteristics and decoration can be used to relate the sherds to identified ceramic types. Decorative modes that are found on these sherds include incising, punctating, appliqué, brushing, and brushing with incising. Design elements and motifs were difficult to define due to the small sizes of the decorated surfaces. Design elements include horizontal lines of fingernail punctations and incisions, linear and curvilinear appliqué, and directionality of brushing. These elements appear to form motifs such as horizontal parallel incisions below the rim, vertical brushing on the vessel body, and parallel lines of fingernail punctations below the vessel rim. Some motifs such as curvilinear appliquéd lines on the vessel body are suggestive of east Texas Caddo ceramic types. Caddo vessels are known from other central Texas sites suggesting regional interaction through trade (Perttula et al. 2003). Caddo type descriptions used here are taken from Suhm and Jelks (1962).

Eleven sherds were submitted to the Archaeometry Laboratory at the University of Missouri Research Reactor Center for instrumental neutron activation analysis (INAA) and to Dr. Steve Tomka (Raba Kistner Consultants, Inc.) and Dr. Lori Barkwill-Love (The University of Texas at San Antonio) for petrographic analysis. Appendixes B–D present the results of these studies. In addition, Appendix E contains an assessment by Dr. Timothy Perttula of the INAA and petrographic results.

Other Materials

Other materials collected for analysis are animal bones, mussel shells, a small number of snail shells, and botanical remains (some as individual samples but mostly obtained through flotation after completion of fieldwork). The vertebrate faunal materials were submitted to Michael J. Quigg of TRC Solutions for analysis; they are reported in Appendix A, with Chapter 5 presenting additional information on them obtained through further analysis by Prewitt and Associates staff. Chapter 5 also contains information on the invertebrate remains. Leslie L. Bush of Macrobotanical Analysis examined the botanical remains (Appendix F).

CHAPTER 3: RESEARCH DESIGN

Because the transition from testing to data recovery excavations had to occur quickly due to the construction schedule for the bridge replacement, no fully developed research design was prepared at that juncture. It was recognized that the Toyah phase component had the potential to contribute important information on topics such as intrasite patterning and the delineation of activity areas, subsistence and economic activities, and interregional contact and interactions, and all parties agreed that extensive excavations with good spatial controls (i.e., manual excavations in 1x1-m units) would be needed to realize this potential, but this was as far as research design planning went between January and April 2004 (i.e., completion of testing and commencement of data recovery). About seven months after the data recovery fieldwork was finished (in February 2005), TxDOT issued a work authorization to prepare a research design to guide all remaining analyses. That effort, which unfolded over about two years, attempted to craft a comprehensive document that would be useful for studying Toyah phase sites in general, not just the Jayroe site. Ultimately, TxDOT concluded that the resulting research design was not focused enough to be easily usable, and thus they did not adopt it for continued analysis of the data recovered in the excavations.

Research design preparation was begun again in Fall 2016, when TxDOT archeologist Jon Budd prepared a draft document outlining some specific hypotheses and analyses that he had identified as being important for interpreting the site. In response to that, Prewitt and Associates prepared an overall framework for the analyses that remained to be done; this chapter presents that document in only slightly modified form, followed by Budd's original research design. As of Fall 2016, many largely descriptive analyses had been completed (under a work authorization issued in November 2013), but the data and interpretations from these analyses had not been integrated into an overall site interpretation. That could be accomplished only by identifying the range of activities performed at the site, determining why the cultural materials were organized spatially the way they were, and identifying whether and how behaviors such as residential mobility and group interaction are reflected in the archeological remains. These three overarching objectives are of varying scales and scopes. The first one builds upon data obtained through the earlier analyses. The second and third ones then build on the first to create a picture of what Native Americans did at the site, how those activities were organized and arranged, and how use of this one site fits within the larger picture of the Toyah phase. As part of a multiregion archeological phenomenon (i.e., Toyah), the Jayroe site cannot be fully understood in isolation. For that reason, the research design called for comparisons between it and other well-documented Toyah sites to lend context and clarity to understanding the assemblages, activities, and behaviors identified archeologically.

IDENTIFYING THE RANGE OF ACTIVITIES

Identifying the activities performed at the site entails pulling together evidence from the already-analyzed artifacts and other assemblages to address tool production, use, maintenance, and discard; feature construction and use; food acquisition and processing; and the acquisition and use of other materials. Many of the attributes examined to identify a certain activity, such as tool use, can also contribute to the identification of other activities such tool production, food acquisition, and food processing. In addition, many of the attributes examined can tangentially address subtopics such as the paleoenvironment and intensity of resource use.

Feature Construction and Use

Feature construction and use can be identified based on their dimensions, morphology, composition, internal constituents, and cultural material associations. Topics to be addressed included feature use histories and quantities of food cooked, and identified macrobotanical remains and charred bones could provide information on the types of foods processed and fuels used. A review of the existing literature, particularly those publications focusing on hot rock features in Texas (e.g., Black, Ellis, et al. 1997; Black and Thoms 2014; Thoms 2008) could aid in interpreting the features.

In summary, the task proposed was:

- Summarize feature data and review existing relevant literature on hot rock features to address feature construction and use.

Tool Production, Use, Maintenance, and Discard

The attributes recorded for the artifacts could provide insights into the production of tools, their use, maintenance, and discard. Continued study of the production of chipped and ground and battered stone tools would focus on identifying the raw materials used in their manufacture. The findings from an earlier lithic survey conducted by Prewitt and Associates throughout the Leon River basin above the Jayroe site could aid in the identification of stone materials used at the site for tool production. For the chipped stone tools, data from the cores and a sample of the debitage could provide insights into the state of the raw materials brought into the site and the stages of manufacture that occurred onsite. Tool use, both chipped and ground and battered stones, could be identified based on use wear on working edges and faces and identification of functional tool classes. Residue analysis, such as cross-over immunoelectrophoresis (CIEP), could be used to identify animal proteins at the family level (e.g., Bovidae) (see Kooyman et al. 1992; Moore et al. 2016; Newman et al. 1996). Tool maintenance could be identified through evidence of rejuvenation of working edges on chipped stone tools and repurposing of broken and worn tools. Tool discard must consider the state of the tool, whether it was broken through use or manufacture and therefore purposefully abandoned, or complete and therefore accidentally lost with remaining use life. A consideration of tool fracture types and patterns could be informative for aspects of tool manufacture, tool use, and discard patterns. Attributes recorded and described for the pottery sherds could provide information on the production, use, and discard of ceramic vessels at the site. Several sherds have residues adhering to their exterior surfaces, residues that may be identified through CIEP. Overall, the various artifact and assemblage attributes could not only offer insights into the sequence of tool production, use, maintenance, and discard at the site, but also provide a picture of overall site use and use intensity that would contribute to realizing the third research objective.

In summary, the tasks proposed were:

- Identify stone raw material types and summarize findings of earlier lithic source survey.
- Compile and summarize core and debitage data for identifying manufacturing stages.
- Identify and summarize data on chipped and ground and battered stone tools use wear.
- Carry out residue analysis (CIEP) on selected stone tools and ceramic sherds.
- Compile and summarize data on chipped stone tool resharpening and recycling.
- Compile and summarize data on chipped stone tool fracture types.

Food Acquisition and Processing

Data from the vertebrate and invertebrate faunal and macrobotanical assemblages could provide information on the kinds of animals and plants hunted and collected. The types of skeletal elements in the vertebrate faunal assemblage offer insights into whether the large prey species (e.g., artiodactyls) were taken relatively near the site or far from it and what parts were transported back to the camp, if entire carcasses are not represented in the assemblage. Skeletal elements, along with cut marks and fracture patterns, could provide insights into how carcasses were processed and consumed. Skeletal elements, shells, and charred plant foods also offer information on caloric and nutritional values of the food acquired and processed. These data also provide insights into the environmental conditions at and surrounding the site and the time of year it was occupied. Stable carbon isotopes on bison bone collagen and the age structure of the bison and deer remains could be used to address these environmental and seasonality issues.

In summary, the tasks proposed were:

- Compile and summarize skeletal element data of large prey species (artidactyls).

- Compile and summarize cut mark and fracture pattern data from vertebrate faunal assemblage.
- Identify and summarize caloric and nutritional values for select food sources.
- Identify and summarize seasonality and environmental data from vertebrate faunal and macrobotanical assemblages.
- Identify and summarize age structure data from artiodactyl remains.

Acquisition and Use of Other Materials

Other materials, such as rocks for cooking features and firewood, could be identified and potentially sourced. Such information would provide insights into where these resources were obtained and possibly the amounts of labor involved in obtaining them for use at the site based on the distances of the sources.

In summary, the tasks proposed were:

- Identify and summarize feature rocks and sources.
- Compile and summarize firewood taxon data from macrobotanical assemblages.

ORGANIZATION OF THE SITE AND ACTIVITIES

The archeological remains of activities tend to be spatially patterned within sites. These patterns can be examined through a low-resolution analysis of the artifact, ecofact, and feature distributions and associations. Ferring (1984) discusses two types of intrasite spatial analysis: spatial clustering and compositional patterning. Each is useful for examining site structure and organization of different archeological contexts. The former examines material density distributions, typically depicted on isopleth maps, while the latter is a density-free examination of the spatial distribution of selected classes of artifacts, ecofacts, and features, for example, the repeated co-occurrence of two tool classes or that of a specific tool type with cooking features (Ferring 1984:116–117). Both spatial clustering and compositional patterning provide significant examinations of site structure and organization, as they not only provide clues about past activities but also the intensity or frequency with which they were carried out and the possible interrelationship between different activities. An analysis of site structure and organization via spatial clustering can produce high-resolution results for single occupation events, however, the results are less robust when the cultural debris of multiple occupations are co-mingled. As discussed in Chapter 6 (Analytical Units and Chronology), the evidence suggests that the Jayroe site saw repeated occupations by multiple generations of the same socioethnic group or groups linked by a common material culture (i.e., Toyah) over a relatively short time span. As other studies have demonstrated, many sites with multiple occupations over reasonably short time spans in a variety of settings have remnant spatial patterning that can be informative about intrasite arrangement of activities, intensity of use, frequency of reoccupation, and group size (e.g., Fields and Gadus 2012:304–309; Gadus et al. 2006:151–163; Mehalchick and Kibler 2008:106–114, 319–328). It was expected that low-resolution spatial analysis of the Jayroe site data could be similarly informative.

The distribution of features can provide information on how activities were arranged spatially, with many camp activities likely centered around hearths. For groups like the !Kung, most manufacturing and cooking activities take place near the family hearth (Yellen 1977:53). Stevenson (1991:277) notes that exterior hearths are frequently the loci of social life and activities in hunting and gathering societies, particularly in temperate and warm climates. Prehistorically, patterns of individual family hearths, and hence family activity areas, have been interpreted for sites throughout central Texas (Johnson 1994:263–265) and the Plains (Davis 1983; Quigg 1983), although this pattern clearly is not unique to these areas (Binford 1983:149–162). The spatial distribution of smaller family hearths and larger communal features, such as large earth ovens or refuse piles, also offers insights into the allocation of communal and private family spaces within a campsite.

The spatial distribution of artifacts and other cultural materials also can provide information on how activities were arranged within the campsite and how the site was maintained throughout its occupation. Debitage distributions hint at tool production areas, particularly the distribution of small flakes of the same material since large flakes often were removed for use as tool blanks or removed and deposited as refuse due to their greater visibility. The distribution of faunal remains can provide insights into food processing and refuse areas within the site. If skeletal elements from the same animal (e.g., equal-sized right and left tibias), but associated with different features, can be identified, this may demonstrate evidence of meat sharing between family groups, further supporting the idea of family and communal spaces within the camp.

In summary, the tasks proposed were:

- Examine and summarize spatial distribution of features by type, function, and size.
- Examine and summarize compositional patterning of faunal, macrobotanical, tool class, and feature co-occurrences.
- Examine and summarize compositional patterning of faunal and feature co-occurrences.
- Examine and summarize compositional patterning of faunal and tool class co-occurrences.
- Examine and summarize compositional patterning of multiple tool class co-occurrences.

MOBILITY, INTERACTION, AND THE JAYROE SITE'S PLACE IN THE TOYAH WORLD

Analysis of artifact, ecofact, and feature assemblages coupled with low-resolution analysis of compositional patterning also could allow interpretations about group mobility and interaction, which in turn could contribute to an understanding of how the Jayroe site relates to other Toyah sites. Kibler (2012:80–83) recently suggested that the Toyah homeland of central Texas and adjacent areas of the Gulf coastal plain was a risk-laden environment, the result of dynamic and variable seasonal and annual climatic (particularly rainfall) patterns. Several proxy data sets indicate that this was particularly true during the Toyah period (A.D. 1250–1700) (Bousman 1998; Forman et al. 2009; Lohse, Madsen, et al. 2014:10; Toomey et al. 1993:299). Climatic conditions such as these tend to produce environments of low resource predictability and fluctuating resource densities. These types of resources can result in unpredictable shortfalls, a risk that hunter-gatherers must guard against through a variety of risk-reduction strategies. Dyson-Hudson and Smith (1978) suggest that hunter-gatherer groups in environments of irregular resource density and unpredictability might practice a high degree of residential mobility and be receptive to information sharing and interactions with other social groups within ill-defined or fluid territories that for the most part were not defended (this is not a given, though, since the opposite, i.e., increased conflict, would be another logical outcome of unpredictability). With a strategy of mobility to mitigate resource uncertainties, it becomes important to “remain as informed as possible about conditions in adjacent or even distant areas” (Johnson 1989:372). Intergroup interaction and the exchange of information become vital risk-reduction strategies under such circumstances. This requires broad social networks (Braun and Plog 1982; Wiessner 1982a). Under conditions of considerable uncertainty, groups tend to monitor each other, maintaining social relationships over large areas, relationships that can be called on in times of need (Johnson 1989:384–385; Wiessner 1982b).

Information sharing and interaction with other social groups are often evident in the Toyah archeological record by the presence of exotic materials, which can be viewed as physical representations of socioeconomic relationships over large areas (Kibler 2012). Assessing this for the Jayroe site is straightforward. Are exotic artifacts and materials present? What do they consist of? Where did they originate? How might they have ended up in the hands of the Toyah occupants of the site? The archeological and ethohistorical literature offer a number of models of socioeconomic relationships across the central Texas and surrounding regions in the latter part of the Late Prehistoric and early Historic periods that can be used to address the last question (Arnn 2012a; Baugh 1998; Girard et al. 2014; Kenmotsu 2001; Kenmotsu and Arnn 2012; Wade 2003).

Residential mobility is a risk-reduction strategy commonly attributed to Toyah peoples, often in terms that convey a very high level of mobility (e.g., Collins 1995:388). Mobility influenced Toyah hunter-gatherer material culture in the sense that material possessions had to be limited in number due to the cost of transporting materials from site to site. Hence, employment of such a strategy would have affected what materials entered the archeological record and how they entered it. Tools, weapons, shelters providing protection from the elements, personal adornment items, and features for cooking, processing, and storage all had to adhere to the demands of mobility. These are tangible pieces of evidence that allow inferences about the length of occupations, whether movements between sites were short or long distances, and how material culture met the demands of mobility. Tied to these issues of mobility are length of occupation and use intensity, which refers to how a site was used, what resources were used, and what technologies were employed while a site was occupied before it ultimately was abandoned. Duration of occupation and use intensity are broad in the sense that they subsume a multitude of behaviors, including aspects of food acquisition and tool kit production and use.

Several kinds of archeological data can provide insights into the length of an occupation of a site, or use intensity, and by inference determine how mobile groups were. One can look at the kinds of resources used and the costs of obtaining those resources. Toyah sites across the region display a strikingly consistent and similar suite of material remains, including great numbers of artiodactyl (particularly bison) remains. Artiodactyls were largely available year-round and were a high-ranked resource that provided many calories from meat and marrow. This resource probably was the initial target of acquisition for hunters and gatherers once a campsite was chosen or a resource patch entered. This behavior resulted in a widespread archeological pattern throughout the region. However, this is not to say that lower-ranked resources were not taken if the opportunity presented itself.

With few exceptions, resources other than artiodactyls can be considered lower-ranked resources, and their presence in archeological assemblages would suggest longer occupations. Use of lower-ranked resources would suggest that artiodactyls were dwindling to the point that the cost of their acquisition was rising. These lower-ranked resources usually consist of small-bodied vertebrates, such as reptiles (e.g., turtles and snakes) and small mammals (e.g., rodents and rabbits) and invertebrates such as mussels. The duration of an occupation could have been extended through the use of lower-ranked resources, a phenomenon that should be evident in the archeological record. The number and variety of lower-ranked faunal remains in terms of Number of Identified Specimens (NISP)—and the ratios of lower-ranked fauna to artiodactyls—should provide insight into whether a site supported short-term or lengthy occupations.

Firewood was another vital resource for hunter-gatherer groups like the Toyah, and the taxa of the downed limb wood collected and used for campfires can be indicative of the duration of a site's occupations. The use of self-pruning arboreal species within the Leon River riparian zone (e.g., pecan and deciduous oaks) would imply relatively short stays. Longer stays may have depleted firewood sources in the immediate camp area, driving up the costs of collecting firewood as greater distances from camp were traveled to collect it. This may be indicated use of firewood from species not present in the riparian zone (e.g., Ashe juniper, mesquite, live oak, post oak, and blackjack oak).

Obviously, occupants of campsites generate waste materials, and longer occupations generate more debris than brief ones. Refuse has to be managed and living areas maintained to curtail interference with subsequent activities (Stevenson 1991:269). Yellen (1977:78) notes that long-occupied camps of the !Kung are better organized largely through waste management, which results in a greater number of dumps or secondary refuse piles. Refuse clearing often produces secondary refuse dumps on the peripheries of camps or intensively or repeatedly occupied activity areas (Stevenson 1991:275). In cleaning, smaller objects are often left behind, no matter how thorough or often cleaning occurs, while larger objects get removed. The result is that secondary refuse dumps should consist primarily of larger objects. The content and context of the materials can also aid in determining whether a feature represents a secondary refuse dump. An examination of the number, size, and location of secondary refuse dumps within the site can then provide information on the duration of occupation. The distribution of unmodified debitage size classes across a site can provide similar information. Larger debitage should be concentrated away from activity areas if these areas have been cleaned.

With the onset of site abandonment, refuse should no longer be subject to the same level of cleanup, size sorting, and dispersal as during the earlier periods of occupation (Stevenson 1991:279). Discarded items from activities that occur late in an occupation, regardless of size, should remain grouped around hearths, whereas large objects used and discarded earlier would be found in secondary refuse piles away from hearths and along the periphery of the camp (Stevenson 1991:280). As previously noted, lower-ranked resources should enter the camp in the later stages of occupation if the occupation is relatively long. Therefore, remains of these lower-ranked resources should have a limited presence in secondary refuse piles and a more-dominant presence around the hearths. Artiodactyl remains, particularly larger elements, should be present in greater numbers than remains of low-ranked resources in the secondary refuse dumps if the occupation was lengthy. This assumption is not only consistent with optimal foraging theory but with ethnographic data as well (Stevenson 1991:283).

Long-term occupations witness more activities. The more times an activity requiring tools is performed, the more wear and breakage of tools occur. Even though many of these tools are part of a mobile tool kit and are brought into sites with use wear and edges already resharpened, use-broken tools and those with little or no remaining use life should be more common in sites that were occupied longer, because tool use lives tend to exceed the length of occupation at short-term sites. To further examine this assertion, the ratio of unmodified debitage to finished formal chipped stone tools, which provides a measure of the frequency of tool discard, can be calculated. Worn and use-broken chipped stone tools have to be replaced, and unmodified debitage is a meaningful byproduct of this action for determining the relative length of occupation. The amount of unmodified debitage is a good measure of length of occupation because, unlike other chipped stone artifacts (e.g., formal tools), the removal of unmodified debitage far from its locus of production is less probable. Burned rock densities also may provide information on use intensity.

Yellen (1977:77) offers this obvious general rule: the longer a site is occupied, the greater the probability that any particular activity will occur there. Different activities may require different suites of tools and features, so that not only would longer occupations result in a greater number of tools and features but a greater diversity of tools and features as well. Assemblage diversity can be measured in terms of richness and evenness. Richness indexes measure the number of classes or categories in a sample or assemblage (Kaufman 1998:77). The more categories or classes present, the richer it is. A richness index ($R = S/\sqrt{N}$) derived by Menhinick (1964) can be used in such an analysis. In this equation, greater values of *R* indicate increasing richness, *S* is the number of classes or categories, and *N* represents the total number of specimens within the assemblage. Another assemblage aspect, evenness, describes the relative frequencies of specimens within each of the classes or categories across the assemblage, or the degree to which all classes or categories are equally represented (Kaufman 1998:77). Unfortunately, many measures of evenness have inherent problems that make them unreliable measures of heterogeneity in most cases (Bobrowsky and Ball 1989). Due to these limitations, Kaufman (1998:77–78) uses a measure relating to variance, specifically the coefficient of variation (the standard deviation divided by the mean number of specimens per class) of each assemblage, to describe evenness. In this case, greater evenness is indicated by smaller values of the coefficient of variation. The jackknife technique is then applied to the two measures (richness and evenness) of diversity, because each measure is dependent on assemblage size. This technique involves repeatedly recalculating the statistic of interest (richness or evenness), each time eliminating one of the classes or categories (Kaufman 1998:75). These calculations produce a series of jackknife estimates, which are used to generate a set of corresponding pseudovalues, the mean of which provides the best estimate for the statistic of interest. The relationship between richness and evenness can be examined in terms of site function, where general campsites are represented by high richness and low evenness values and specialized activity sites are represented by low richness and high evenness values. In this context, we assume the former represent longer occupations.

If Toyah peoples' knowledge of the environment told them that resource density was high in a particular area, they may have anticipated lengthier stays at sites. This concept of "anticipated mobility"—length of time people expect to occupy a site—was found to be important among the San and Bantu peoples (Kent 1991). Kent's (1991:38) study showed that anticipated mobility was more influential in determining site structure and the number of square meters per person, a rough index of labor investment at a camp, than group size or how long the group actually lived there. All the sites in Kent's (1991) study with an anticipated short length of occupation had a value of less than 33 m^2 per person. That works out to site sizes of 825 to 2,475 m^2, assuming groups or bands consist of 25–75 people as suggested by Jochim (1976) and Kelly (1995:209–213). Determining the number of square meters per person, or even the size of the area used by site occupants during a single occupation, based on archeological data is difficult, but there are other ways to determine anticipated mobility using archeological information. Since anticipated mobility also influences site structure, the anticipated duration of occupation should be reflected in the proximity of individual households or private family areas to each other. The closer the households, the shorter the anticipated stay. Assuming that small hearth features represent individual family hearths (and hence family spaces), the distances between hearths might provide insight into whether a group anticipated a short or long stay. Probably more important, the anticipated length of occupation might give us a better understanding of a group's knowledge of their environment.

Distances that hunter-gatherers moved between campsites can vary greatly (Kelly 1995:128–130). Again, this is a dimension of mobility that cannot be measured in the archeological record, but insights into whether movements were relatively short or lengthy might be possible based on tool curation and the distances to stone sources. If opportunities to replace tools are few, meaning immediate access to adequate sources of stone is limited due to distance, tools should show evidence of intense reworking. However, if a source of material is close by, tools may not display much evidence of intense curation and resharpening. Along the Leon River in the vicinity of the Jayroe site, small chert gravels can be found on some of the gravel bars, but in limited numbers. Because of their small size and limited numbers, they may have been exploited only for the production of small expedient flake tools. The closest known sources of sizable chert clasts and nodules are ca. 27 to 43 km away (see Chapter 6, Identifying the Range of Activities, Procurement of Other Resources, for a discussion of potential lithic source areas). Unless procurement of lithic raw materials was embedded in or part of the daily foraging strategy (e.g., Binford 1979:259), or the foraging radius included adequate sources of stone, groups would have moved closer to the source areas to obtain raw materials. Given the distance to the known sources, a high degree of tool curation in the form of intense resharpening and edge rejuvenation ought to reflect short (less than ca. 27–43 km) moves between campsites for the Toyah occupants, since tool replacement opportunities would have presented themselves rarely, if ever. However, if tools do not display a high degree of curation, it could reflect longer distances moved between camps—movements that would present procurement and tool replacement opportunities. The ratio of formal tools, in this case projectile points and bifaces, that exhibit resharpening to those that do not may be indicative of the distances moved between campsites. The use of a tool form that was highly durable, versatile, and amenable to edge rejuvenation and promoted a high level of curation may have negated the need for frequent tool replacement and hence frequent trips to stone sources. This idea is explored in greater detail below, but it would tend to support the idea of short-distance movements in the chert-poor vicinity of the Jayroe site, since such tools designs are often used in areas where sources of stone are limited (Kelly and Todd 1988:237–238).

Mobility influences hunter-gatherer material culture in the sense that material possessions are few due to the cost of transporting materials from site to site. Among the !Kung, most of a nuclear family's possessions can be carried by a single adult (Yellen 1977:64). Transport costs of material possessions can be minimized in several ways, such as limiting transported materials to those used to acquire resources, namely chipped stone tools and associated shafts (the presence of ceramics in Toyah sites might seem inconsistent with this, but sherds are few at most sites, suggesting small numbers of vessels that may not have presented transportation challenges). We assume that high mobility results in tools or tool kits that would provide the greatest potential utility relative to the cost of transporting them. Tool kits of mobile hunters and gatherers should be composed of a limited number of lightweight tools so as to minimize transport costs, while at the same time ensuring that the tools are as durable, maintainable, and multifunctional as possible (Kelly and Todd 1988:237; Kuhn 1994:426). Tools should be capable of dealing with a broad and changeable set of actions or needs and designed to last until there is an opportunity to replace them (Kuhn 1994:427). Durability and multifunctionality require increased overall tool size, but this benefit is outweighed by increased transportation costs (Kuhn 1994:426). Smaller tools, while less costly to transport, tend to have potentially detrimental implications because tool use life and functional versatility are too limited. The optimal artifact design is thus the one that produces the greatest potential utility relative to the cost of transporting it (Kuhn 1994:429). Bifacial tools have that capacity if made of high-quality stone. Bifaces can have fairly sharp but durable edges that can be repeatedly resharpened, and from which flakes can be removed for expedient use, all within a thin and low-mass form (Kelly and Todd 1988:237). If bifaces are the optimal tool form in terms of portability and potential utility, versatility, and durability, then these tool forms should easily outnumber all other tool forms at the sites if mobility is high. These optimal tool forms should give way to more task-specific or expedient tools if mobility decreases and site use becomes intense and lengthy (Kelly and Todd 1988:240). A utility/mass ratio derived from Kuhn's (1994) measure of potential utility versus transport costs for bifacial tools may provide even more insights into the degree of mobility. Using complete or nearly complete bifacial tools, the utility/mass ratio examines a tool's potential utility in the form of the number of working edges and their total length versus its transport costs in the form of its weight. Higher ratios would be indicative of higher degrees of mobility.

Many, but perhaps not all, of these measures of mobility may be applicable to not only the Jayroe site but also other Toyah sites to get a broader sense of residential mobility among Toyah peoples. In the same sense, we can look at the presence of exotic materials at other Toyah sites to get an idea of the greater social network that existed for Toyah peoples. Such comparisons ought to give us a better idea not only of the size and scope of the Toyah socioeconomic network, but also some sense of the identity of the players within this network.

In summary, the tasks proposed were:

- Compile and summarize exotic artifact and material data.
- Review appropriate existing literature to identify relevant regional models of socioeconomic networks.
- Calculate artiodactyl/lower-ranked resources ratio using NISP.
- Compile and summarize riparian and nonriparian sources of firewood from macrobotancial assemblage.
- Compile and summarize compositional and distributional data on secondary refuse features.
- Calculate unmodified debitage/finished formal chipped stone tool ratio.
- Calculate richness and evenness indices for stone tool assemblage.
- Calculate "anticipated mobility" index.

- Calculate ratio of projectile point and bifaces that exhibit resharpening to those that do not exhibit resharpening.
- Calculate utility/mass ratio of bifacial tools.
- Compare above measurements and indices to those from other Toyah sites where appropriate data are readily available.

RESEARCH DESIGN DEVELOPED BY THE TEXAS DEPARTMENT OF TRANSPORTATION

Theoretical Orientation

The Late Prehistoric archeological site known as 41HM51 is located approximately 9 miles north of the community of Hamilton in Hamilton County, Texas. The site, situated on the north bank of the Leon River, was discovered in 2003 during efforts of the Texas Department of Transportation to address the environmental issues associated with a bridge replacement project. It was subsequently determined eligible for listing on the National Register of Historic Places under Criterion D: data likely to yield information important to prehistory. Because it could not be avoided, it was subject to data recovery in the spring of 2004 by Prewitt and Associates on behalf of TxDOT.

Low-velocity flooding from the adjoining Leon River gently buried fire hearths, animal bones, pottery sherds, debitage, and stone tools soon after the Indians had abandoned them. Radiocarbon assays date the deposits from roughly A.D. 1220 to 1790 with 75 percent of the occupations dating from A.D. 1400 to 1700. A total of 48 projectile points were collected. In addition, a total of 16 features were observed. A single obsidian projectile point along with a small amount of obsidian flakes were also recovered. A total of 43 ceramic vessel sherds along with a robust faunal assemblage of extensively fragmented bone were retrieved from the site.

The online version of the Texas Archeological Sites Atlas reveals that, at the time of this writing, there have been a total of 62 archeological sites formally recorded within Hamilton County. Many less of these are prehistoric, and even less date to the Late Prehistoric phase. Site 41HM51 is the only Late Prehistoric archeological site in Hamilton County that was determined to be significant and excavated by professional archeologists. This means that currently very little is known about the behavior of the Late Prehistoric occupants of Hamilton County. Therefore, anything we can learn from this site will enlighten us about the aboriginal occupation of that place and time.

What questions can be answered by data retrieved from the site? This endeavor has settled on two basic lines of inquiry. The first general inquiry seeks to answer the question: What were the types of behavior engaged in by the Toyah phase occupants that best explains the formation of the faunal, lithic, ceramic, and feature assemblages recovered at 41HM51? The second line of inquiry seeks to address the question: How do the site's assemblages compare with current theoretical models attempting to explain the terminal prehistoric in central Texas.

Cultural Context

The cultural development of central Texas where 41HM51 is located has been divided into the Paleoindian, Archaic, Late Prehistoric, and Historic Periods (Black, Ellis, et al. 1997; Collins 1995; Prewitt 1981). The Paleoindian period ended at approximately 6800 B.C. and was originally defined as small mobile groups following herds of large herbivores across the landscape with infrequent reoccupation of campsites. This period has been redefined to also encompass an exploitation of a broader spectrum of resources then just large herbivores. Sites from this period are rare due in part to few contexts that retain preservation and due to erosion. Gradual warming from the previous Pleistocene Ice Age characterizes the climate for this period. Projectile points from the Paleoindian period in Texas include Agate Basin, Angostura, Barber, Clovis, Eden, Folsom, Hell Gap, Jimmy Allen, Lerma, Meserve, Midland, Milnesand, Plainview, and Scottsbluff (Turner and Hester 1999).

The subsequent Archaic period (6500 B.C. to A.D. 750) represents the longest cultural period of development in south-central Texas. A continuation of the warming trend that began at the close of the Pleistocene set the stage for this 7,250-year-long period. It is characterized by small territorial bands of hunter-gathers that routinely returned to choice areas, exploited a wide range of plant and animal resources, and used rock-lined earthen ovens. Distinctive trends in projectile point style in Texas have been recognized by archeologists in classifying these tools in order to delineate this period into the Early, Middle, and Late Archaic stages. The Early Archaic (6500 to 4000 B.C.) is characterized by early split-stem projectile point types: Andice, Baker, Bandy, Bulverde, Jetta, Martindale, and Uvalde (Turner and Hester 1999). The Middle Archaic (4000 to 1500 B.C.) is indicated by the presence of Abasolo, Almagre, Bell, Carrollton, Charcos, Dawson, Early Triangular, Lange, Langtry, Nolan, Pandale, Pandora, Refugio, Travis, and Williams (Turner and Hester 1999). The Late Archaic (1500 B.C. to A.D. 750) is characterized by projectile points types known as Axtell, Carrizo, Conejo, Darl, Edgewood, Elam, Ensor, Fairland, Frio, Gary, Godley, Kent, Kinney, Marcos, Montel, Morhiss, Palmillas, Pedernales, Shumla, Tortugas, Wells, and Yarbrough (Turner and Hester 1999).

The Late Prehistoric period (A.D. 750 to 1750) is further divided by archeologists into Late Prehistoric I and Late Prehistoric II, also referred to as the Austin and Toyah phases. The prominent difference of the Late Prehistoric period from the Archaic period is the presence of distinctly smaller projectile point types associated with the bow and arrow. Another horizon marker is the first appearance of ceramic artifacts. Otherwise, like the Archaic period, the Late Prehistoric period is one where hunting and gathering persisted as the primary adaptation. Archeologists also have classified the point styles of the Late Prehistoric period in central Texas. Projectile point types of the Late Prehistoric I or Austin phase (A.D. 750 to 1250) are: Catan, Desmuke, Edwards, Matamoros, Scallorn, Starr, and Young (Turner and Hester 1999). Point styles of the Late Prehistoric II or Toyah phase (A.D. 1250 to 1750) are: Alba, Bonham, Cliffton, Cuney, Fresno, Perdiz, Toyah, and Turney (Turner and Hester 1999). Archeologists define the close of the Late Prehistoric period at about A.D. 1540 with the influx of European explorers and settlers. The occupation at 41HM51 dates overwhelmingly to the Late Prehistoric II period or the Toyah phase.

Definition of Hypotheses

As mentioned above, this research design proposes to focus analyses of the site constituents on two main objectives. This first objective seeks to identify the types of behavior that the Toyah phase site's occupants engaged in that best explains the formation of the site's faunal, feature, ceramic, and lithic assemblages. The second objective seeks to compare the archeological remains of the site's terminal prehistoric occupants with the feature and artifactual assemblages outlined in major theoretical models pertaining to central Texas. The specific hypotheses regarding these two objectives are discussed below.

Based upon a cursory analysis of the cultural deposits, the first objective is to propose that the formation of the 41HM51 site assemblages involved behavior associated with the production and trade of pemmican. Pemmican is a nutrient-rich dish created by Native Americans. Rich in protein and fat, pemmican was both filling and dense in calories and nutrients. It is portable and long lasting. It was a way for Native Americans to store food for the winter and an excellent trade item (Karr et al. 2008). Various recipes existed, based on what was available, but a basic recipe used extremely lean meat, dried fruit, rendered fat, nuts, and perhaps a touch of honey. The meat was dried or cured until it was nearly crispy, after which it was ground or pounded into a powder. The dried fruit (also ground) would be added, and then the rendered fat (bone grease). The ingredients would be mixed by hand along with any nuts or seeds desired, and then allowed to cool. Pemmican could be rolled out into thin strips or made into small wafers or balls that were easy to eat as snacks. This mixture, if prepared properly, could last for years, especially if a little salt was added. During the Late Prehistoric period, pemmican, along with other items such as deer hides (Shafer 2006:10) and transportable slabs of chert, were likely highly valued trade items within the Caddo agricultural settlements located in eastern Texas.

To validate the conclusion, a series of hypotheses are proposed. This research design also explains what types of data will be required to test these hypotheses, how they will be tested (methods), clear explanations of the test results, and how the test results validate the objective's conclusion.

Hypothesis 1: The Toyah Phase Site Occupants Engaged in Bone Grease Extraction Behavior

Bone grease extraction usually involves fracturing defleshed long bones (femurs and tibia) with a large boulder used as an anvil and a handheld stone used as a hammer. The resulting bone fragments are then placed in boiling water that cooks the bone grease out of the spongy cancellous material (Karr et al. 2008). After the grease has been cooked out of the bone fragments, the water is allowed to cool and the resulting grease separates and floats on top of the water where it can be easily skinned off. Bone grease is an integral ingredient in the production of pemmican. There are distinctive elements in archeological sites that signify bone grease extraction behavior. These elements are outlined below.

DATA REQUIREMENTS/METHODS

Comminuted Bone: The data required to test this hypothesis includes the results of an analysis of the site's Toyah phase faunal assemblage. This analysis quantifies the amount in terms of percent, of the comminuted (fragmented) deer, antelope, and bison long bone fragments measuring 5 cm or less in size. A preponderance of bone fragments measuring 5 cm or less is usually interpreted as evidence of bone grease extraction (Church and Lyman 2003:1). However, taphonomic influences (trampling, weathering, rodent/carnivore gnawing) can also fragment bones. Outram (1998) has defined a process he claims can determine whether a bone fragment was broken when it was fresh (within a few days of the animal dying) or broken due to taphonomic influences long after deposition. Outram calls this the "fresh fracture index" or FFI. This process quantifies the fracture angle, outline, and edge texture to determine FFI. Other faunal specialists (Church and Lyman 2003; Klippel and Synstelien 2013; Quigg 1997) simply imply that bone fragments are associated with bone grease extraction if the fragments are less than and equal to 5 cm and appear to be generated from the long bones of large mammals. A representative sample of fragmented bone from the site's faunal assemblage will be measured to determine if a majority of it is equal to and less than 5 cm. In addition, this sample will be assessed using Outram's FFI criteria to determine if the data from the 41HM51 faunal assemblage support or refute Outram's mode.

Hammer and Anvil Stones: Another form of data required includes the results of an analysis of the site's Toyah phase lithic assemblage. The presence of hammerstones and anvil stones used to break long bones into fragments are also indicators of bone grease extraction behavior. The site's Toyah phase lithic assemblage will be assessed for the presence of hammerstones and anvil stones. In addition, if such stones are present, then these stones or a sample of them will be forwarded to technical experts for analysis to confirm the presence of meat protein residue.

Boiling Stones: The presence of cobbles/stones and or fragments of cobbles/stones that were heated and then used or reused for stone boiling also evidences bone grease extraction behavior. The site's Toyah phase lithic assemblage will be assessed for the presence of these types of stones and fragments. Like above, these stones or a sample of them will be forwarded to technical experts for analysis to confirm the presence of meat protein residue.

Fire Hearth Features: Fire hearth features that were used to extract the grease/fat from bone fragments are another form of data that can be applied to hypothesis 1. These include stone boiling pits that were holes excavated into the ground in order to line with a green (fresh) bison or deer hide. Archeologically, these likely look like subsurface excavations with discolored soil and may still contain cobbles that were fire heated for stone boiling in a fresh bison or deer skin filled with water. These features may also contain concentrations of bone fragments. The bison/deer skin may have been left in situ (if rendered worthless) with boiling stones and bone fragments left inside, or the hide could have been lifted out with stones and bone fragments dumped into the used boiling pit or dumped somewhere else.

Thoms (2008:457) has proposed how the remains of stone boiling pits may appear archeologically. He theorizes that these pits would possess steep slopes and be bucket shaped. However, after hundreds of years, these pits may not have retained the steep siding and may end up resembling shallow basins.

Another hearth feature that may have been involved would be simple fire hearths that were used to heat up stones/cobbles for stone boiling. Archeologically, these would be like simple surface or shallow subsurface fire hearths with cobbles/ stones that were in the process of being heated for stone boiling. It is possible that these hearths may not contain any cobbles/stones for heating because the stones had been taken out and used. These hearths likely were located in close proximity to stone boiling pits in order to make it easier to transport the hot stones.

These simple hearths could have also been used to heat up ceramic pots in order to extract bone grease. Unless the pot was accidentally broken, then no evidence remains. However, if a pot was broken, there would likely be burned sherds. Simple hearths are ubiquitous in prehistoric archeological sites, and their presence alone does not necessarily imply bone grease extraction. Like the anvil/hammer/ boiling stones mentioned above, ceramic sherds from the site will be forwarded to technical experts for analysis to confirm the presence of meat protein residue.

Prehistoric bone grease extraction could have also utilized a skin bag that was constructed aboveground using a wooden or antler frame. It could have also held water and enabled stone boiling. Minimal archeological evidence would remain from this feature. However, simple hearths used to heat up cobbles for stone boiling would be expected to be located nearby.

The sites Toyah phase fire hearth feature assemblage will be assessed to determine the presence of these types of hearth features. In addition, the fire hearth feature remains shall be compared with Thoms's model as well as the fire hearth features documented at other sites where bone grease extraction was theorized to have occurred such as the Head-Smashed-In Buffalo Jump site located in Alberta, Canada (Quigg 1986).

Bone grease residue on the inside of ceramic sherds would also provide data to evidence bone grease extraction behavior. Laboratory analysis of residue on the inside of pottery sherds could confirm the presence of fatty residue. The site's ceramic assemblage will be assessed to determine whether bone grease residue is present.

RESULTS AND IMPLICATIONS

If the site's Toyah phase archeological remains prove positive the presence for a majority of bone fragments measuring 5 cm and less, hammer and anvil stones, the above-defined fire hearths, and bone grease residue on anvil/hammer/ boiling stones and or on the ceramic sherds, then the hypothesis is validated. Inversely, if the site's Toyah phase archeological deposits fail to demonstrate the presence of a majority of the mentioned elements tested for the presence of bone grease extraction behavior, then the hypothesis is proved invalid. In addition, if the faunal assemblage does prove to possess a preponderance of deer, antelope, and bison long bone fragments measuring 5 cm or less and when Outram's FFI index is applied but does not prescribe fresh fracturing of bone, then Outram's model can be questioned. However, if the faunal assessment confirms the presence of both long bone fragments measuring 5 cm and less and a FFI index pointing to fresh fractures, then the Outram model is supported.

Hypothesis 2: Data Related to Bone Grease Extraction Behavior Is Common in Toyah Phase Archeological Sites But Rare in Austin Phase Sites

DATA REQUIREMENTS/METHODS

The data required to test this hypothesis generates from a review of the faunal, lithic, feature, and ceramic analyses documented from representative samples of other archeological sites dating from both the Austin and Toyah phases. These assemblages from the Austin and Toyah phase sites will be assessed for the presence of the elements discussed under the Data/Methods section above for hypothesis 1. Please note that Thompson et. al. (2012:129) noticed that bone fragment frequency decreases during the initial Late Prehistoric (Austin phase) but increases dramatically during the terminal Late Prehistoric (Toyah phase).

Austin phase sites to compare faunal remains:

Graham-Applegate, 41LL419 (Hixson 2003)

Pat Parker, 41TV88 (Greer and Benfer 1975)

Lion Creek, 41BT105 (Johnson 1997)

Zavala, 41ZV202 (Mauldin et al. 2010)

Shepard, 41WM1010 (Rogers 2006)

Hoxie Bridge, 41WM130 (Bond 1978)

Wilson Leonard, 41WM235 (Baker 1994; Collins 1998)

41HY476 (Dowling and Butler 2011)

Evoe Terrace, 41BL104

Frisch Auf!, 41FY42 (Hester and Collins 1969)

Jetta Court, 41TV51

Dobias-Vitek, 41WM118

Toyah phase sites to compare faunal remains:

East Levee, 41TG91(Creel 1990; Johnson 1994:245–246)

Buckhollow, 41KM16 (Johnson 1994)

Rainey Sinkhole, 41BN33 (Johnson 1994:250–251; Henderson 2001)

Possum Creek, 41KL201 (Johnson 1994:254–256; Highley 1986)

Hinojosa, 41JW8 (Johnson 1994:251–254; Hester 1977; Black 1986)

Rush, 41TG346 (Quigg 1997)

Rowe Valley, 41WM437 (Rush 2013)

Varga, 41DE28 (Quigg et. al. 2008)

Jayroe, 41HM51

Barker, 41WM71 (Sorrow 1970)

Berclair, 41GD4 (Hester and Parker 1970)

Finis Frost 41SS20 (Green and Hester 1973)

Site that possess both Austin and Toyah phase components to compare faunal remains:

Mustang Branch, 41HY202 and 41HY209 (Ricklis and Collins 1994)

Smith Rockshelter, (41TV42) (Johnson 1994:248–250)

41SS178 (Hixson et al. 2011)

Loeve Fox, 41WM230 (Prewitt 1982)

Baylor, 41ML35

Kyle Shelter, 41HI1 (Harris 1960; Jelks 1962; Johnson 1994:246–248)

Oblate, 41CM1

Penny Winkle, 41BL23

Wheatly, 41BC114 (Greer 1976)

RESULTS AND IMPLICATIONS

If the majority of Toyah phase sites in the sample possess most of the above elements (especially the bone fragments), then the portion of the hypothesis stating that bone grease extraction behavior was common during the Toyah phase will be validated. However, if the opposite is true, then that portion of the hypothesis is proven to be invalid.

If the majority of sites from the Austin phase lack the preponderance of bone fragments as well as the other elements listed above under data requirements, then the portion of the hypothesis stating that bone grease extraction behavior was rare during the Austin phase is validated. However, if the opposite is true, then that portion of the hypothesis is proven invalid.

If the overall hypothesis that bone grease extraction behavior was rare during the Austin phase but common during the following Toyah phase is proven valid, then credence is lent to the conclusion that there is a lack of cultural continuity between the Austin phase and the immediate subsequent, Toyah phase. A rational explanation for this cultural interruption was due to an influx of new migrants who practiced bone grease extraction while the earlier Austin phase people did not. See Logan (1998:349) for a reference to Late Prehistoric migrants exhibiting bone grease extraction entering into a new area in Kansas previously dominated by people who did not engage in bone grease extraction behavior.

Hypothesis 3: The Primary Reason for the Extraction of Bone Grease Was To Use It As a Component in the Production of Pemmican

One of the contributors to Kenmotsu and Boyd's (2012:119) volume on the Toyah phase has proposed that the presence of highly fragmented animal bone in Toyah phase archeological sites is evidence of famine. He defines the preponderance of these fragments as the site occupants using fallback foods or secondary food sources such as bone grease to sustain themselves during times of challenging food shortages. However, Thompson et. al. (2012:121) and Brink (1997:271–272) in Logan (1998:358) cite evidence suggesting that bone fragmentation rates through time are not explained entirely by dietary stress.

An alternative explanation for the motivation for Toyah phase people to engage in bone grease extraction behavior could instead be related to the production of pemmican. Baker (1994:19) states that one of the main uses of bone grease is for the manufacture of pemmican. Pemmican is a nutrient-rich dish created by Native Americans. It was a common food resource on the High Plains. Rich in protein and fat, pemmican was both filling and dense in calories and nutrients. It is portable and long lasting. It was a way for Native Americans to store food for the winter and an excellent trade item (Karr et al. 2008). During the Late Prehistoric period, pemmican, along with other items such as deer hides (Shafer 2006:10) and transportable slabs of chert, likely were highly valued trade items within the Caddo agricultural settlements located in eastern Texas.

DATA REQUIREMENTS/METHODS

The data required to test this hypothesis includes ethnographic/ethnohistoric accounts as well as archeological reports that documents possible motivations for American Indian people to engage in bone grease extraction behavior. A representative sample of these sources will be searched in an effort to discover the motivation behind protohistoric and historic American Indians bone grease extraction behavior.

Another form of data that could be used to test this hypothesis generates from the site's Toyah phase ground stone artifacts. If the site occupants were producing pemmican, they would have used a mano and metate to grind cured/dried meat into powder that would be mixed with bone grease. These artifacts will be subject to laboratory analysis to confirm the presence of residue from the grinding of cured meat.

TEST RESULTS AND IMPLICATIONS

If the majority of the ethnographic/ethnohistoric accounts as well as archeological reports described above reveal that the motivation behind bone grease extraction was the production of pemmican, then the hypothesis is validated.

However, if the majority of the data reveals that bone grease extraction behavior was motivated by dietary stress, then the hypothesis is nullified.

In addition, a positive outcome for the presence of cured meat residue on the site's ground stone implements substantiates pemmican production behavior at the site. However, if on the other hand, the ground stone samples reveal no vestiges of residue due to degradation, then the hypothesis is neither substantiated nor nullified. However, if residue survived but shows vegetable material only, then the hypothesis is weakened.

The implication of validating the hypothesis is that bone grease extraction behavior was not necessarily related to dietary stress but instead related to the production of pemmican. An invalidation of the hypothesis signifies that the opposite is true.

Hypothesis 4: The Site's Lithic Assemblage Suggests That the Site's Toyah Phase Occupants Engaged in Very Limited Migratory Behavior

DATA REQUIREMENTS/METHODS

The data required to test this hypothesis generates from the site's Toyah phase lithic assemblage. The tools and debitage will be sorted by color under ultraviolet fluorescence (UVF) using techniques outlined by Newlander and Speth (2009:48). The results of this UVF analysis will be compared with known chert type collections used as reference materials including fluorescence color variation of cherts from the Panhandle, west, central, southwest, and east Texas as well as from western Louisiana. Additional samples will be obtained from a survey of raw materials within the upper Leon River basin and will be included as comparative material.

TEST RESULTS AND IMPLICATIONS

If the UVF lithic analysis results in the determination that the vast majority of chipped stone artifacts generate from local Leon River valley chert sources, then the hypothesis is validated. If, however, the analysis demonstrates chert sources that are not local to the Leon River valley, then the hypothesis is nullified. If the hypothesis is validated, then that validation lends credence to the conclusion that the Toyah phase occupants were limited in their range of movement and stayed within a fairly limited territory. Therefore, the best explanation for the presence of exotic artifacts within the site would be that the Toyah phase occupants were engaging in long-distance trading behavior, possibly trading surplus pemmican in exchange for obsidian from New Mexico as well as Caddoan ceramics from east Texas.

Hypothesis 5: The Artifacts from the Site's Toyah Phase Can Be Used to Test Shafer's Prairie Caddo Model

The second objective of this investigation into the site's Toyah phase occupants seeks to investigate the overall cultural character of the site's terminal prehistoric occupants based upon a recent theoretical model that has been proposed by a recognized expert in Texas archeology. Shafer (2006) proposes that some Toyah phase site occupations are actually Caddo people who exploited the Texas prairies from A.D. 1000 to 1300. In his model, Shafer proposed a list of artifacts to look for that would identify Toyah phase archeological sites as Prairie Caddo. This list includes metapodial beamers, Alba/Bonham projectile points, Gahagan knives, and early Caddoan pottery.

DATE REQUIREMENTS/METHODS

The data required to test this hypothesis generates from the site's Toyah phase faunal, lithic, and ceramic assemblages. These assemblages will be assessed to confirm the presence or absence of metapodial beamers, Alba/Bonham projectile points, Gahagan knives, and early Caddoan pottery proposed by Shafer to define the site occupants as Prairie Caddo.

RESULTS/IMPLICATIONS

If all of the artifacts proposed by Shafer that define the Prairie Caddo are present, then his model is validated. If some of the artifacts are present, then his model is partially validated. If none of the artifacts are present, then his model is nullified. In any case, the hypothesis that the Toyah phase artifacts can be used to test his model is validated.

CHAPTER 4: GEOMORPHOLOGY

The Jayroe site is within a Holocene alluvial terrace occupying the floodplain on the north side of the Leon River, within a meander bend of the river. The valley bottom is about 1.3 km wide, extending 0.7 and 0.6 km south and north of the river, respectively, in the vicinity of the site (Figure 4.1). The river is incised ca. 6 m below the floodplain surface, which is at an elevation of about 1,030 ft above mean sea level. The adjacent valley walls rise 24–30 m over horizontal distances of 0.6–0.7 km. The Bureau of Economic Geology (1976) maps Holocene alluvium across the project area flanked by the Lower Cretaceous Glen Rose and Twin Mountains Formations.

ALLUVIAL STRATIGRAPHY OF THE LEON RIVER VALLEY

In his study of the stratigraphy and geomorphology of the Leon River and other streams at Fort Hood about 65–100 km southeast of 41HM51, Nordt (1992, 1993, 1995) identified six principal allostratigraphic units (Figure 4.2). From oldest to youngest, these are the Reserve, Jackson, Georgetown, Fort Hood, West Range, and Ford alluvia. The Reserve alluvium is a fill of middle- to late-Pleistocene age that sits atop a bedrock strath and forms the T_3 terrace, which stands about 21 m above the river channel. The Jackson alluvium is approximately 15,000 years old and consists of 3–4 m of gravelly and loamy deposits resting on a bedrock strath. It forms the T_2 terraces, which are about 16 m above the river level. The Georgetown alluvium is buried below the T_1 terrace surfaces, which are 8–9 m above the modern stream. Deposition of this unit began no earlier than 11,300 B.P. and terminated by 8200 B.P. The fill consists of gravelly and loamy deposits. The Royalty paleosol, formed on top of the Georgetown alluvium, typically consists of a truncated Bk horizon containing secondary precipitates of calcium carbonate.

At Fort Hood, T_0 terraces of the Leon River are underlain by three units, the Fort Hood, West Range, and Ford alluvia. On smaller streams there, the Fort Hood unit and sometimes the West Range unit typically compose parts of the T_1 terraces; as described below, this is the case at 41HM51 as well. The Fort Hood alluvium consists of 9–10 m of gravelly and loamy deposits that date between about 8000 and 4800 B.P. The West Range alluvium accumulated in two episodes between 4300 and 600 B.P., with a brief erosional period between 3000 and 2000 B.P. The West Range unit is typically 9 m thick; it partially truncates and buries the Fort Hood alluvium in some areas. Typically, its upper part contains the cumulic Leon River paleosol. The Fort Hood and West Range alluvia aggraded to the same elevation in many

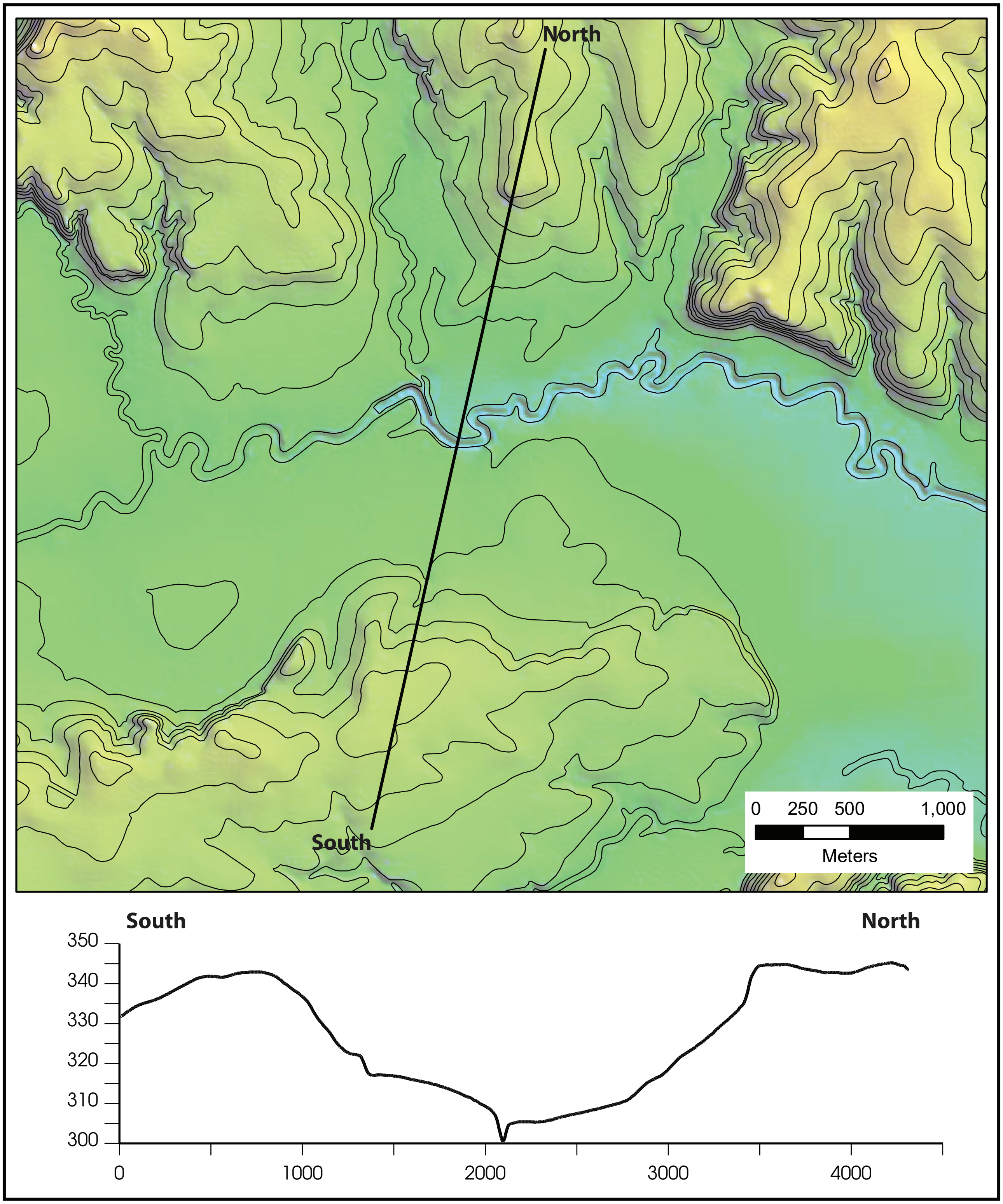


Figure 4.1. Topographic map and cross section of the Leon River valley in the vicinity of 41HM51 (contour lines on the map are at 20-ft intervals; horizontal and vertical scales on the cross section are in meters; cross-section data are from USGS National Elevation Dataset, 10-m resolution, and thus are only generally representative).

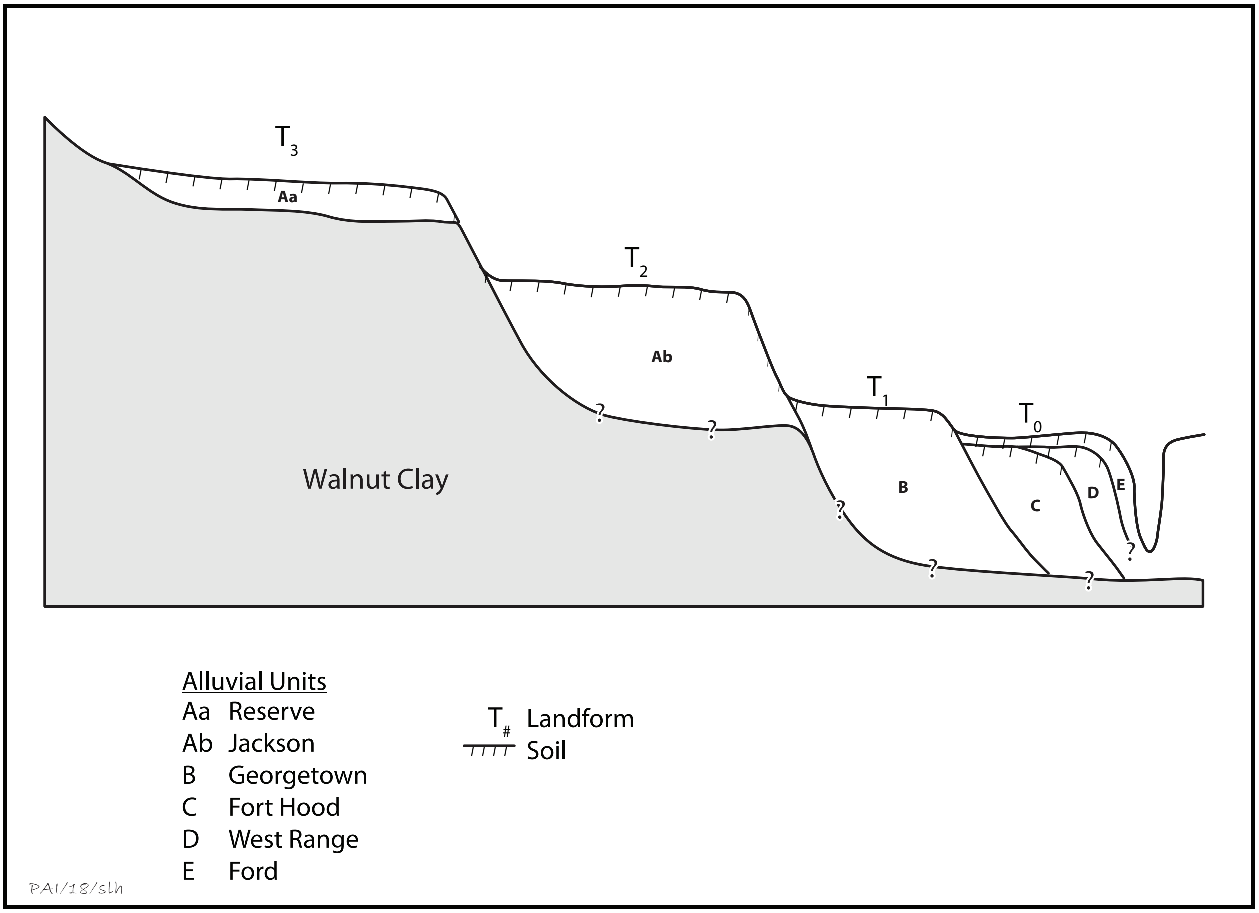


Figure 4.2. Idealized cross section of the Leon River valley in the Fort Hood area showing allostratigraphic units (adapted from Nordt 1992).

of the valleys, making the resulting terrace surfaces diachronic. Deposition of the Ford alluvium and construction of the modern floodplain began 400–600 years ago and are continuing today. In some places, this latest unit is superimposed on both the Fort Hood and West Range alluvia, and in others it is inset against them and creates a lower floodplain surface.

Excavations in 2011–2013 at archeological site 41HM61 on the Leon River 8 km east-southeast of the Jayroe site found deposits correlating with all of the units described above except the Jackson and Georgetown alluvia, with the vast majority of the cultural materials in the West Range unit and much sparser Toyah phase materials in the Ford alluvium (Abbott 2015:37–51). Reserve alluvium was documented atop a T_3 terrace, while Fort Hood, West Range, and Ford alluvia were found in T_1 contexts with the latter also underlying T_0 surfaces.

Frederick and Gregory's (2015) detailed analysis of data from 41HM61 determined that the West Range deposits consisted of upper and lower parts, with a paleosol at the top of each and cultural materials in both. They describe the upper part as having the following characteristics: (1) homogeneous and fine-grained;

(2) containing a paleosol at the top consisting of black (10YR 2/1) silt loam, silty clay, to clay with prominent prismatic structure and numerous calcium carbonate filaments (Akb horizon); and (3) having an underlying Bk horizon of very dark gray to very dark grayish brown (10YR 3/1 to 10YR 3/2) silt loam to loam, also with prominent prismatic structure and more calcium carbonate filaments and discontinuous coats of calcium carbonate on ped faces. The deposit contained no bedding structures and gradually coarsened up-profile (Frederick and Gregory 2015:200). They describe the lower member of the West Range similarly, "exhibiting a wide range of colors, some with 10YR hues (e.g., black [10YR 2/1], dark gray [10YR 4/1], and very dark grayish brown [10YR 3/2]) and others with 7.5YR hues (e.g., dark brown [7.5YR 3/3]) and generally fine textures ranging from loam to silt loam, silty clay, and clay. It typically exhibited moderate to strong prismatic structure and about 5 to 7 percent calcium carbonate filaments. The Bk horizon… was generally brown (7.5YR 4/3 to 7.5YR 4/4) silt loam, silty clay, to clay, and also possessed well-developed prismatic structure and about 7 to 10 percent calcium carbonate filaments. Like the Upper West Range deposits, none of the Lower West Range sediments exhibited evidence of sedimentary stratification or bedding" (Frederick and Gregory 2015:200). Two radiocarbon ages obtained from the lower unit, 3610±30 B.P. on charcoal and 4450±30 B.P. on soil humates, are consistent with the dating estimates based on the work at Fort Hood.

Ford alluvium occurred as both inset fill and terrace veneer facies at 41HM61 (Frederick and Gregory 2015:202–209). The former consisted of 4+ m of highly stratified near-channel overbank deposits, with couplets of alternating fine and coarse sediments representing individual flood events. The coarser sediments were sands and sandy loams ranging from brown (10YR 5/3) to pale brown (10YR 6/3) and very pale brown (10YR 7/3, 10YR 8/2). The finer sediments were loam to silt loam and clay ranging from brown (10YR 4/3) to dark grayish brown (10YR 4/2), very dark grayish brown (10YR 3/2), and black (10YR 2/1). The inset fill facies contained a soil (A-C to A-Bw-C1-C2 profile) with a 15-cm-thick A horizon with no traces of bedding structures. The underlying Bw horizon had slight evidence of bedding, while the C1 horizon below had preserved but bioturbated bedding structures and the C2 horizon had well-preserved structures.

The typically thinner terrace veneer facies of the Ford alluvium consisted of light yellowish brown (10YR 6/4) loamy sand to brown (10YR 4/3) sandy loam and loam and very dark gray (10YR 3/1) silt loam. Bedding structures were preserved mostly where it was thickest, i.e., in C horizons proximate to inset fill facies. Soil development was stronger than in the inset fill facies, with an A-AC-C profile. The A and AC horizons were 15 cm thick each. Cultural materials assignable to the Toyah phase were present at the base of the terrace veneer facies at its contact with West Range alluvium and in a dipping lens within the inset fill facies. Seven radiocarbon dates obtained on charcoal, bison bones, a charred corn kernel, and a charred tuber fragment from both facies yielded ages of 250±30, 290±30, 300±30, 335±20, and 380±30 B.P., consistent with the dating estimates based on work at Fort Hood.

SEDIMENTS AND STRATIGRAPHY AT 41HM51

The sediments and stratigraphy at the Jayroe site were documented in the trenches dug during survey and testing. These trenches were on a single constructional surface representing a flood terrace (T_1), which on the north side of the Leon River is divided into T_{1a} and T_{1b} components by a ca. 1-m-high scarp. The T_{1a} surface stands ca. 6 m above the channel, while the T_{1b} terrace surface is ca. 4–5 m above the channel.

The T_{1b} terrace was documented during survey with Trench 1 about 20 m north of the river channel and 15 m south of the scarp separating the T_{1a} and T_{1b} surfaces (Figure 4.3). Trench 1, which was devoid of cultural materials, was 1.9 m deep and exposed sediments that were slightly modified (A-Bw soil profile). The A horizon (0–81 cm) is dark grayish brown (10YR 4/2) silty clay loam, and the Bw horizon (81–190+ cm) is brown (10YR 5/3) very fine sandy clay loam. Both soil horizons exhibit 2–5-cm-thick discontinuous beds of light yellowish brown (10YR 6/4) sand, some with interbedded mud laminae. Based on the preservation of these structures and the limited soil formation, the T_{1b} surface appears to be recent in age, with the underlying sediments probably correlating to the Ford alluvium documented downstream at 41HM61 and at Fort Hood.

The higher T_{1a} surface is underlain by two alluvial fills. Toyah phase materials were concentrated in the upper part of the earlier one and the lower part of the later one, with the earlier unit also containing Late Archaic remains. The soil stratigraphy of these two units was documented in Trenches 2 and 3 during testing and all of the trenches and units dug during testing and data recovery. It is summarized below based on exposures in Trenches 4, 7, and 9 (see Figure 4.3).

The north wall profile of Trench 4 and associated Test Units 1, 2, and 9 revealed a 75–85-cm-thick, slightly modified younger alluvial mantle exhibiting an AC-C soil profile overlying an older unit capped by a dark cumulic soil. The AC horizon of the younger unit is 15–30-cm-thick grayish brown (10YR 5/2) silty clay loam. The C horizon is 60-cm-thick pale brown (10YR 6/3) to brown (10YR 5/3) silty clay loam. Discontinuous thin beds of sand are present throughout the horizon. The underlying older unit is imprinted with a 2Ab-2Bwb soil profile. The 2Ab horizon is 60–70-cm-thick very dark grayish brown (10YR 3/2) clay loam. It displays moderate medium blocky subangular structure and common insect burrow casts. The soil is cumulic, and cultural materials such as freshwater mussel shells and burned rocks were observed throughout the horizon. The underlying 2Bwb horizon is grayish brown (10YR 5/2) clay loam displaying moderate medium blocky angular structure.

The west wall of Trench 7 and associated Test Units 7, 8, and 10 about 35 m north of Trench 4 displayed a ca. 225-cm-thick AC-C-AC'-2Ab-2Bwb soil profile (Figures 4.4 and 4.5). The AC-C-AC' horizons are developed in the younger alluvial unit. The AC horizon is 20–25-cm-thick brown (10YR 5/3) silty clay loam, and the C horizon is a 70–80-cm-thick series of interbedded very pale brown (10YR 7/3) very fine to fine sand and brown (10YR 5/3) sandy mud thin laminae to thin beds. These laminae and beds are slightly contorted. The AC' horizon is 20–30-cm-thick mottled grayish brown (10YR 5/2) and dark grayish brown (10YR 4/2) fine sandy clay

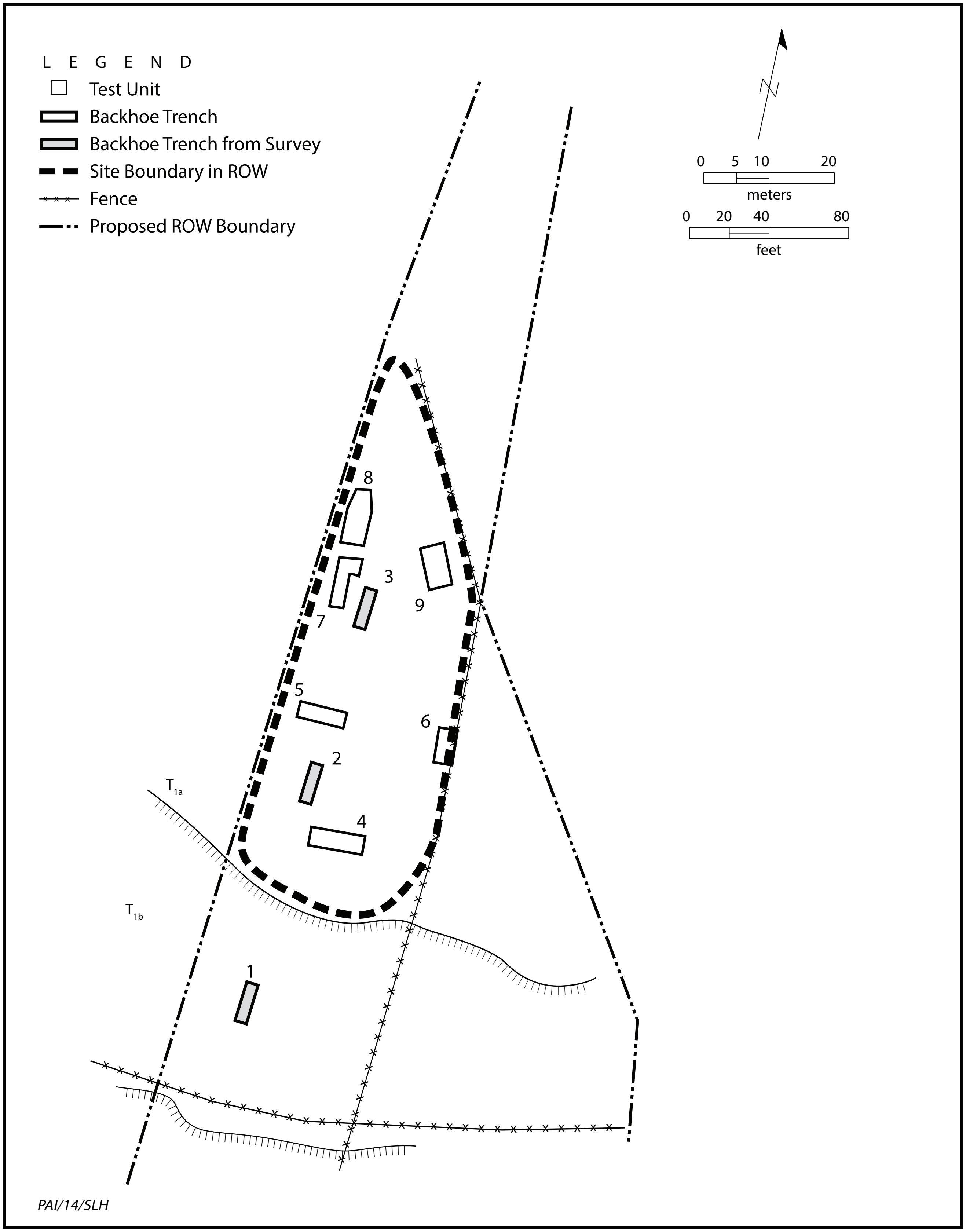


Figure 4.3. Plan of 41HM51 showing the survey and test excavations. Site locations are not shown in report copies for public distribution.

loam. Small (insect- and worm-size) burrow casts are common. An abrupt boundary separates the AC' horizon from the 2Ab horizon imprinted on the older unit. The 2Ab horizon is 50–55-cm-thick very dark grayish brown (10YR 3/2) clay loam. It exhibits moderate fine blocky subangular structure and common small burrow casts. The soil is cumulic, and cultural materials were observed within and on top of the horizon. The 2Bwb horizon is dark grayish brown (10YR 4/2) clay loam that is 50+ cm thick. It exhibits weak medium prismatic structure that breaks to moderate fine blocky angular structure. Cultural materials such as charcoal, freshwater mussel shells, and burned rocks were observed throughout the horizon.

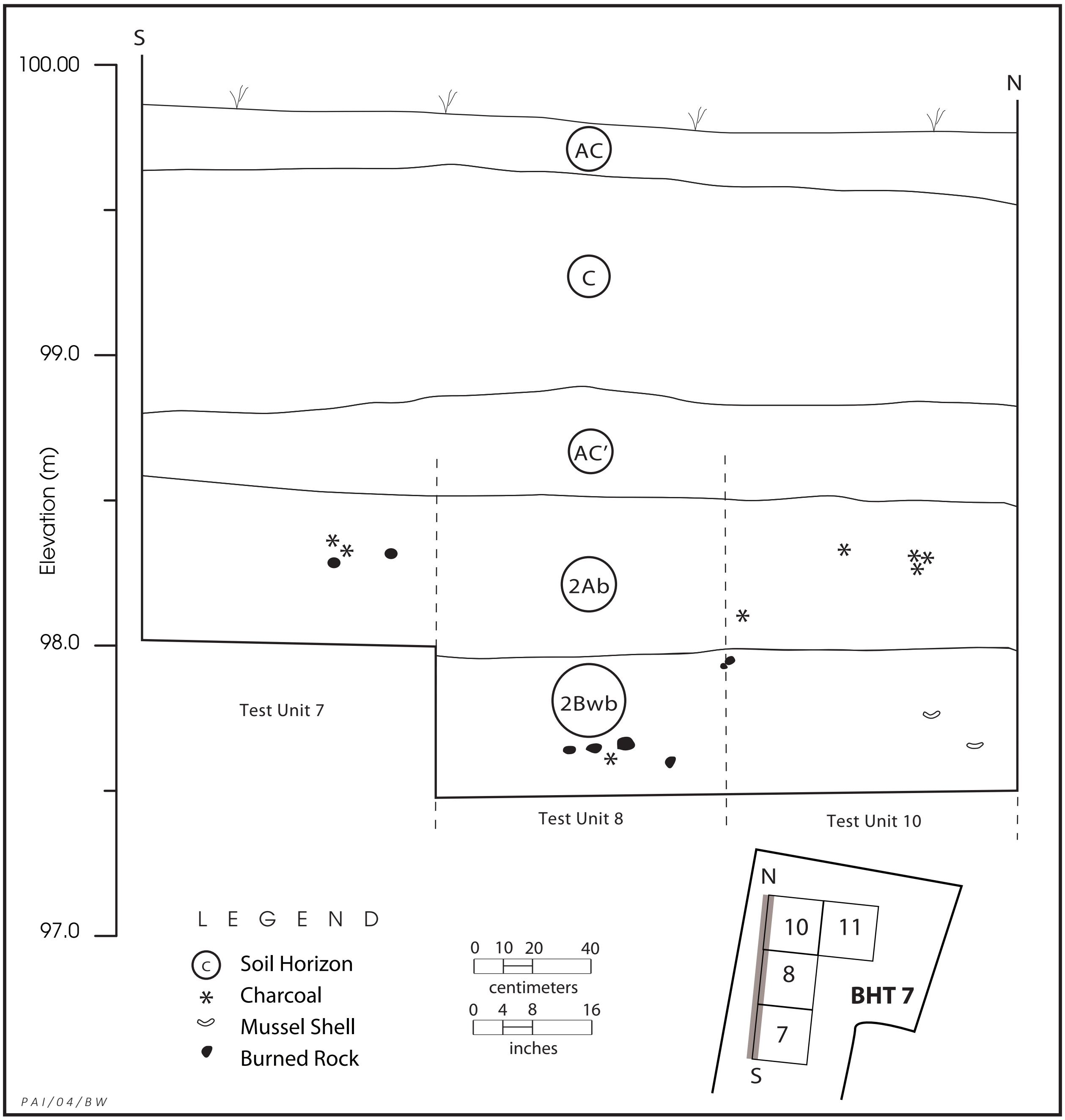


Figure 4.4. West wall profile of Test Units 7, 8, and 10 in Trench 7.

Figure 4.5. View to the north of Trench 7 with AC-C-AC' horizons in younger alluvial unit exposed in the walls and Test Units 7 and 8 dug into the 2Ab horizon in the floor of the trench.

About 15 m east of Trench 7, the east walls of Trench 9 and associated Test Units 16, 17, and 19, along with the north walls of Test Units 15 and 17, revealed a ca. 290-cm-thick profile, of which only the lower ca. 105–130 cm were recorded in detail (Figures 4.6 and 4.7). Much of the exposed profile consisted of the younger alluvial unit, the bottom 20–35 cm of which was recorded and represents a C-AC soil profile comparable to that described above in Trench 7. The C horizon consists of horizontal and crossbedded thin beds and laminae of pale brown (10YR 6/3) very fine to fine sand and dark gray (10YR 4/1) mud. The underlying AC horizon is 5–13-cm-thick dark grayish brown (10YR 4/2) sandy clay loam. Cultural materials such as charcoal and burned rocks were observed throughout the AC horizon. An abrupt lower boundary separates the AC horizon from the 2Ab horizon imprinted on the older alluvial unit. The 2Ab horizon is 55-cm-thick very dark gray (10YR 3/1) clay loam with moderate medium blocky subangular structure. Charcoal, burned rocks, and small burrow casts are common. Cultural features rested on top of the buried soil and also intruded into it. The underlying 2Bwb horizon is dark gray (10YR 4/1) silty clay loam displaying moderate fine blocky angular structure; it is 25+ cm thick.

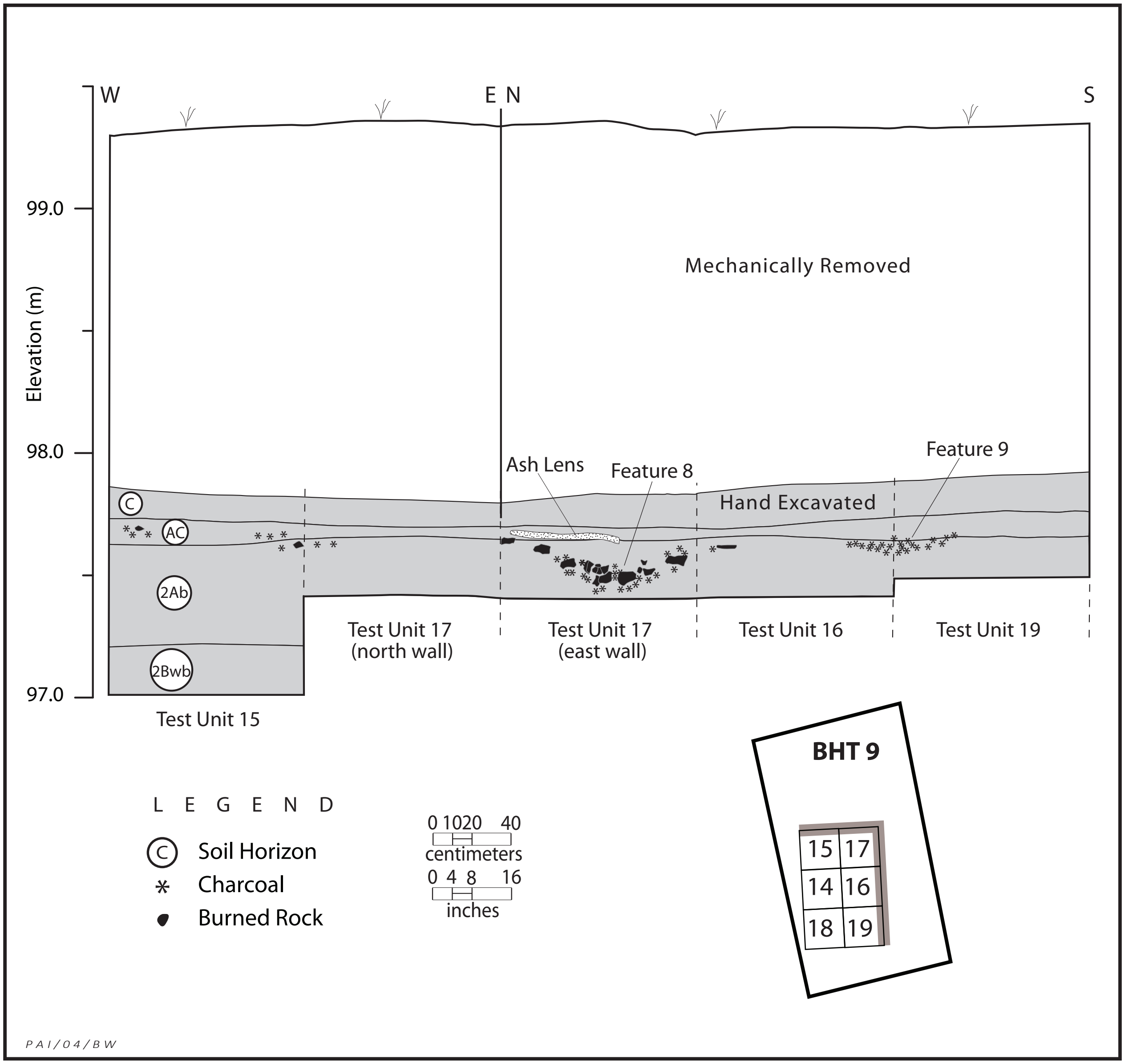


Figure 4.6. East wall profile of Test Units 16, 17, and 19 and north wall profile of Test Units 15 and 17 in Trench 9.

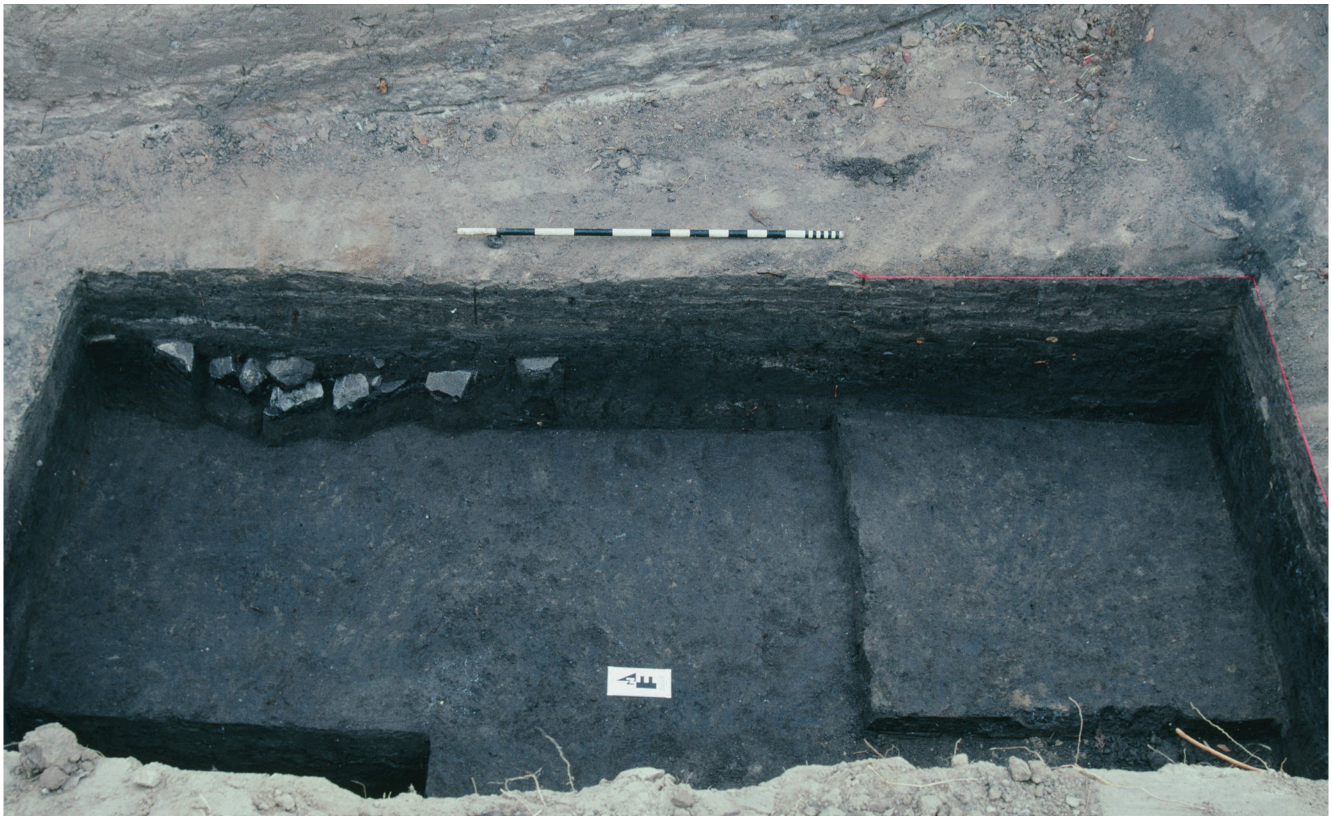


Figure 4.7. View to the east of Test Units 16, 17, and 19 dug into the 2Ab horizon in the bottom of Trench 9, with laminated sediments of C and AC horizons at the bottom of the younger alluvial unit above.

The Toyah phase component is just above and within the upper part of the paleosol imprinted on the lower alluvial unit. This paleosol is similar to the Leon River paleosol identified downstream at Fort Hood in its pedogenic characteristics and geomorphic position (Mehalchick et al. 1999; Nordt 1992, 1993), and thus the lower unit at 41HM51 probably correlates to the West Range alluvium documented there. Radiocarbon dates indicate that the Toyah materials at 41HM51 date predominantly to the A.D. 1400s (see Chapter 6), which is consistent with the 600 B.P. terminal age for the West Range unit at Fort Hood. Also consistent is the occurrence of Late Archaic materials deeper in the unit.

The younger unit above the palesol is interpreted as thinner Ford alluvium correlative to the deposits beneath the lower T_{1b} terrace (Figure 4.8). The surface of this unit is nearly level, but it varies in thickness from ca. 70 cm near the southern end of the site to just over 200 cm on the north and northeast sides. The paleosol surface atop the underlying West Range alluvium slopes down to the north about 120 cm over this same distance, and because evidence indicates that this elevation change is not due to truncation of that surface by erosion (see Chapter 6), it appears that surface was constructional, perhaps representing a levee. If so, the river likely occupied its current course during the Toyah occupation, with the area away from the river (i.e., on the north and northeast sides of the site) being lower terrain more susceptible to wet conditions. The dark, sometimes mottled and burrow-ridden sandy clay loam sediments at the contact between the Ford and West Range units in parts of the block excavation are consistent with this, although the ubiquitous presence of cultural materials across the excavation indicates the area was not sufficiently wet to prevent occupation. Subsequently, the terrace aggraded to the point where the northward slope is no longer topographically visible on its surface.

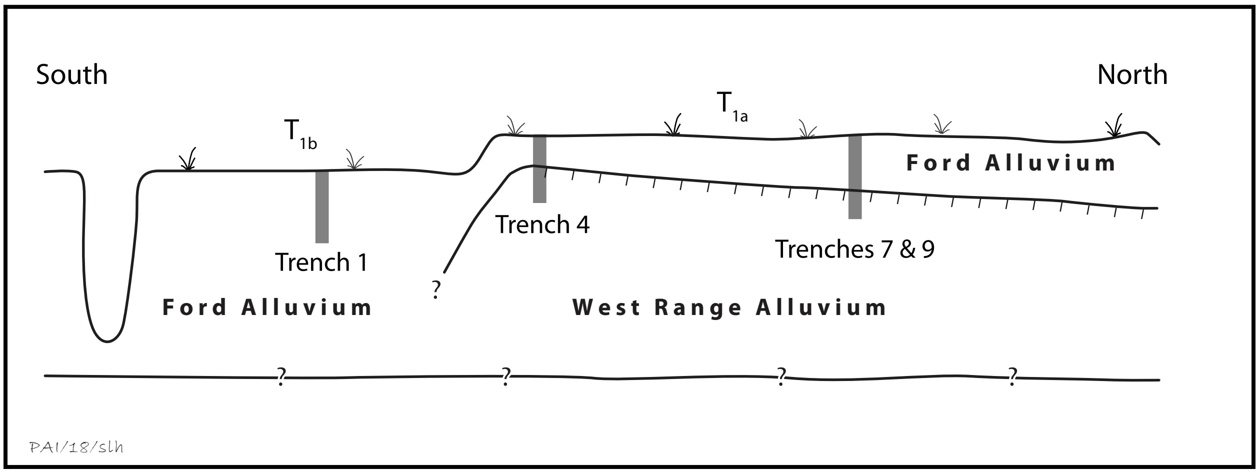


Figure 4.8. Schematic south-north cross section of the Jayroe site showing allostratigraphic units.

CHAPTER 5: FEATURES, ARTIFACTS, AND ECOFACTS

This chapter contains descriptions of the cultural features, artifacts, and ecofacts recovered during both phases of work. It also includes basic interpretations, but higher-level interpretations based on these data sets are reserved for Chapters 6 and 7. Supporting information for the descriptions can be found in various appendixes.

CULTURAL FEATURES

Eighteen features were recorded during the testing and data recovery excavations (Figure 5.1; Table 5.1). Nine (designated Features 1–9) were documented during the testing phase, and 9 more (designated Features 10–18) were recorded during the data recovery investigations. A postfield assessment found that Features 1 and 2 were not cultural in origin, but rather they were amorphous to semicircular soil anomalies characterized by contrasting textures and colors relative to the surrounding matrix. Careful excavation in and around these 2 failed to produce any artifacts, nor did they have clearly definable horizontal and vertical margins. They seem to have been the result of differential wetting. Feature 18 was identified after the data recovery excavations ended. It is a knapping station or lithic reduction area defined when it was noticed that all of the materials recovered from one level of one excavation unit were flakes of the same chert material (based on color and texture). The remaining features are an assortment of basins containing burned rocks, ash, or charcoal; burned rock clusters; and clusters of vertebrate or invertebrate faunal remains. Eleven (Features 4, 8–11, and 13–18) were found at the paleosol surface. The other 5 (Features 3, 5–7, and 12) were found at various depths (from 15 to 84 cm) below that surface.

Features from Testing

Feature 3

Feature 3 is near the center of Test Unit 9 in Trench 4 at the south end of the site at an elevation of 98.71–98.67 m. It is a cluster of five burned rocks and one freshwater mussel shell fragment (Figure 5.2). Four of the rocks and the mussel shell are confined to an area of 25 cm north-south by 12 cm east-west, and the fifth rock is about 22 cm distant from the concentration. The four central burned rocks are 5–10 cm in maximum dimension, and the outlier is less than 5 cm. The total weight of burned rocks is about 0.8 kg. While the rocks do show some overlap, they form only a single layer. There is no indication they were in a pit. No artifacts were

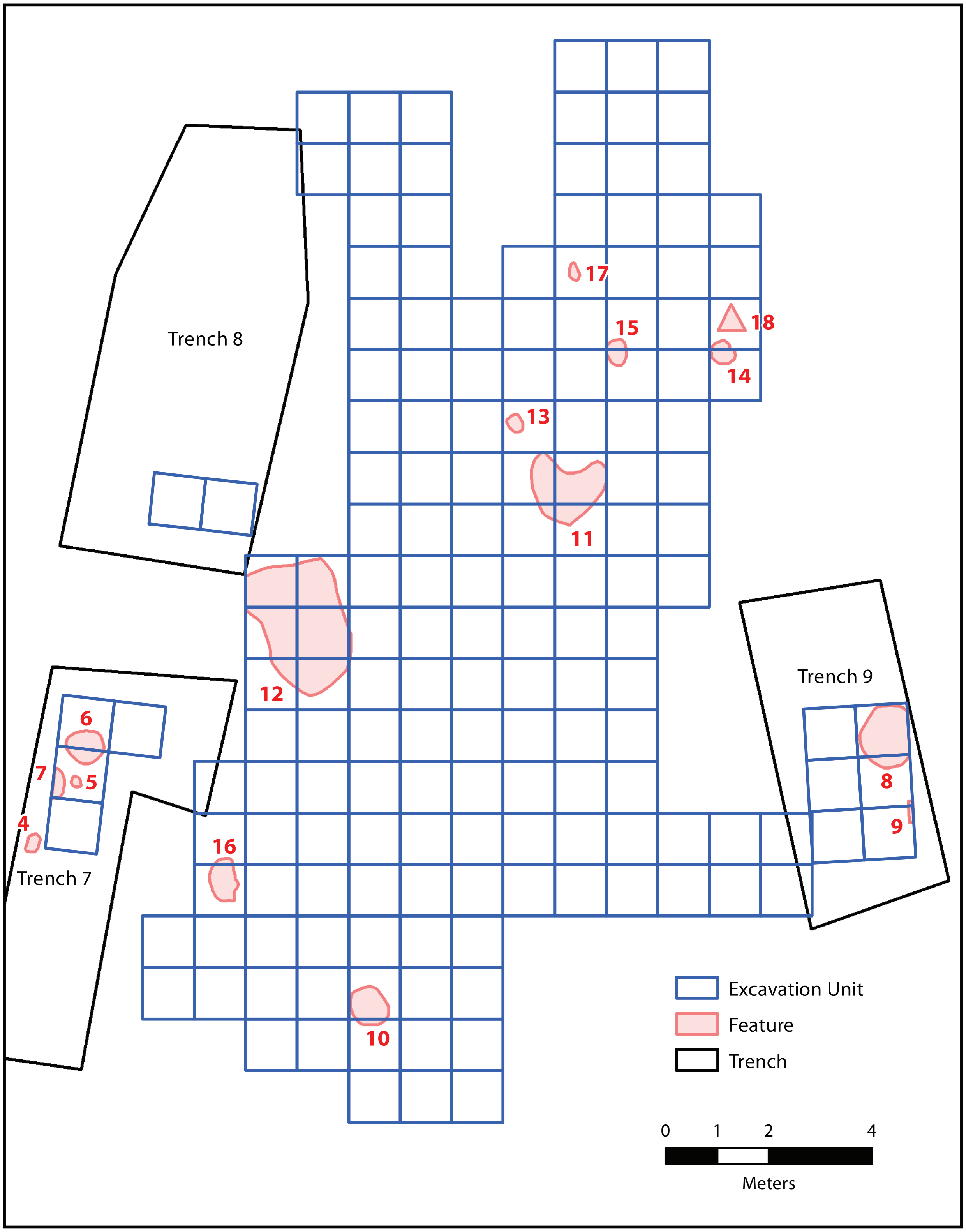


Figure 5.1. Plan of data recovery excavations and adjacent test units showing locations of cultural features (Feature 18 is shown schematically, since it was defined after fieldwork. Feature 3, in Test Unit 9 at the south edge of the site, is not shown).

found in association. The matrix surrounding the rocks was collected for flotation. The heavy fraction contains 13 rodent mandible fragments weighing 0.1 g. The light fraction was not analyzed because charred botanical materials are sparse or absent. Feature 3 is interpreted as a scatter of materials cleaned out of an unidentified nearby hearth or earth oven. Its base rests 15–20 cm below the paleosol surface.

Table 5.1. Summary of features

No.	Location	Description	Interpretation
1	TU 2	soil anomaly	noncultural
2	TU 1	soil anomaly	noncultural
3	TU 9	burned rock concentration with mussel shell	debris scatter
4	Trench 7	pit with ash, burned rocks, and charcoal	open hearth
5	TU 8	burned rock concentration	debris scatter
6	TU 8	pit with burned rocks and charcoal	shallow earth oven or surface hearth
7	TU 8	mussel shell scatter	debris scatter
8	TU 16 and 17	pit with burned rocks, burned clay, and charcoal	shallow earth oven or surface hearth
9	TU 16 and 19	pit with burned clay, charcoal, and ash	open hearth
10	EU 13 and 14	pit with burned rocks, burned clay, and charcoal	shallow earth oven or surface hearth
11	EU 44, 45, 47, and 48	bone concentration	debris scatter
12	EU 25–28, 81, and 82	mussel shell scatter	debris scatter
13	EU 85	burned rock, lithic artifact, and bone concentration	debris scatter
14	EU 145 and 153	pit with ash and charcoal	open hearth
15	EU 96, 97, 133	bone concentration	debris scatter
16	EU 152 and 156	pit with burned rocks and charcoal	shallow earth oven or surface hearth
17	EU 136	burned rock and lithic artifact concentration	debris scatter
18	EU 145	flake concentration	knapping area

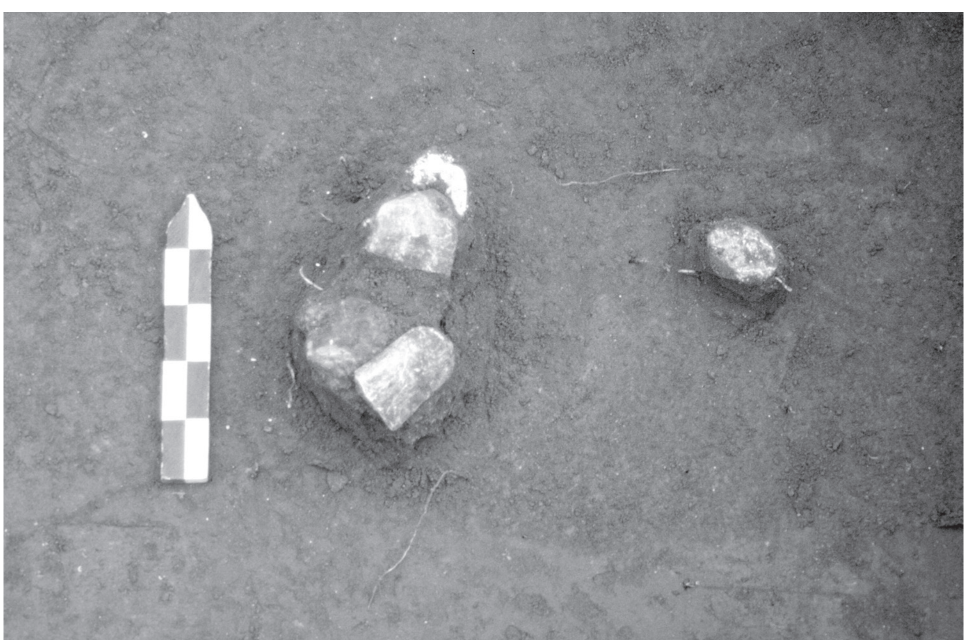


Figure 5.2. Photograph of Feature 3.

Feature 4

Feature 4 is a pit found at the bottom of Trench 7, approximately 30 cm west of the southwest corner of Test Unit 7, at an elevation of 98.49–98.39 m. Its detection level is about 9 cm below the surface of the paleosol, with its uppermost part probably removed by the backhoe in trench excavation. Hence, the pit originally may have been about 19 cm deep. It is an irregularly oval shallow basin measuring 25 cm east-west by 36 cm north-south (Figure 5.3). The basin contains ash in a sandy clay loam matrix with moderate amounts of calcium carbonate and charcoal flecks. Three small burned limestone rocks with an estimated total weight of 0.1 kg are along the edges of the basin. The fill was collected for flotation. The heavy fraction contains 86 burned antler tine fragments weighing 22.6 g, 1 mussel shell, 25.5 g of burned clay, and 1.1 g of charcoal. The light fraction yielded 2.75 g of charred botanical material. Identified remains consist of 0.23 g of wood charcoal (mostly white group oak, but also elm, hickory/pecan, mulberry, and indeterminate hardwood), 0.22 g of charred pecan nutshell fragments, and 1 charred hawthorn seed. A sample of unidentified wood charcoal collected from the west edge (98.46 m elevation) produced a corrected radiocarbon age of 390±40 B.P. (UGA-13208), with a calibrated two-sigma date range of A.D. 1436–1529/1544–1634. This feature is interpreted as an open hearth.

Feature 5

Feature 5 is in Test Unit 8 at an elevation of 98.29–98.21 m about 30 cm south of Feature 6 (Figure 5.4). It is a small, roughly circular concentration of burned rocks arranged in a single layer with no overlap. All but 2 of the rocks are in an area 20 cm in diameter, with the 2 outliers to the south. There is no evidence it is in a pit, and thus it appears to be a dump of materials removed from a hearth or earth oven. Its base is ca. 29 cm below the top of the paleosol. The 10 burned rocks weigh 1.1 kg and generally measure 5–6 cm in diameter, although they range from 3 to 11 cm. The matrix surrounding them was collected for flotation. The heavy fraction contains 3 chert flakes, 125 pieces of bone weighing 37.5 g, and less than 0.1 g of charcoal. The bones consist of 5 deer or deer-sized humeri, vertebra (axis), and long bone fragments; 1 indeterminate long bone fragment; and 119 indeterminate specimens; the vast majority, 122, are less than 3 cm in size, and 7 are burned. The light fraction contains 1.07 g of charred botanical material containing white group oak (0.03 g) and hawthorn (0.02 g) wood charcoal.

Feature 6

Feature 6 is a pit in the northern end of Test Unit 8 and the southern end of Test Unit 10 at elevations of 98.29–98.15 m. Its top is 21 cm below the top of the paleosol. It is a shallow basin containing burned rocks and charcoal with a band of charcoal-enriched sediments along the perimeter suggesting in situ burning. The feature is roughly circular measuring approximately 66x68 cm (see Figure 5.4). In cross section, it has an upper 6-cm-thick zone of very dark grayish brown sandy clay loam with charcoal inclusions and somewhat dispersed burned rocks underlain by a band of almost pure charcoal 4–5 cm thick; below that at the bottom of the basin

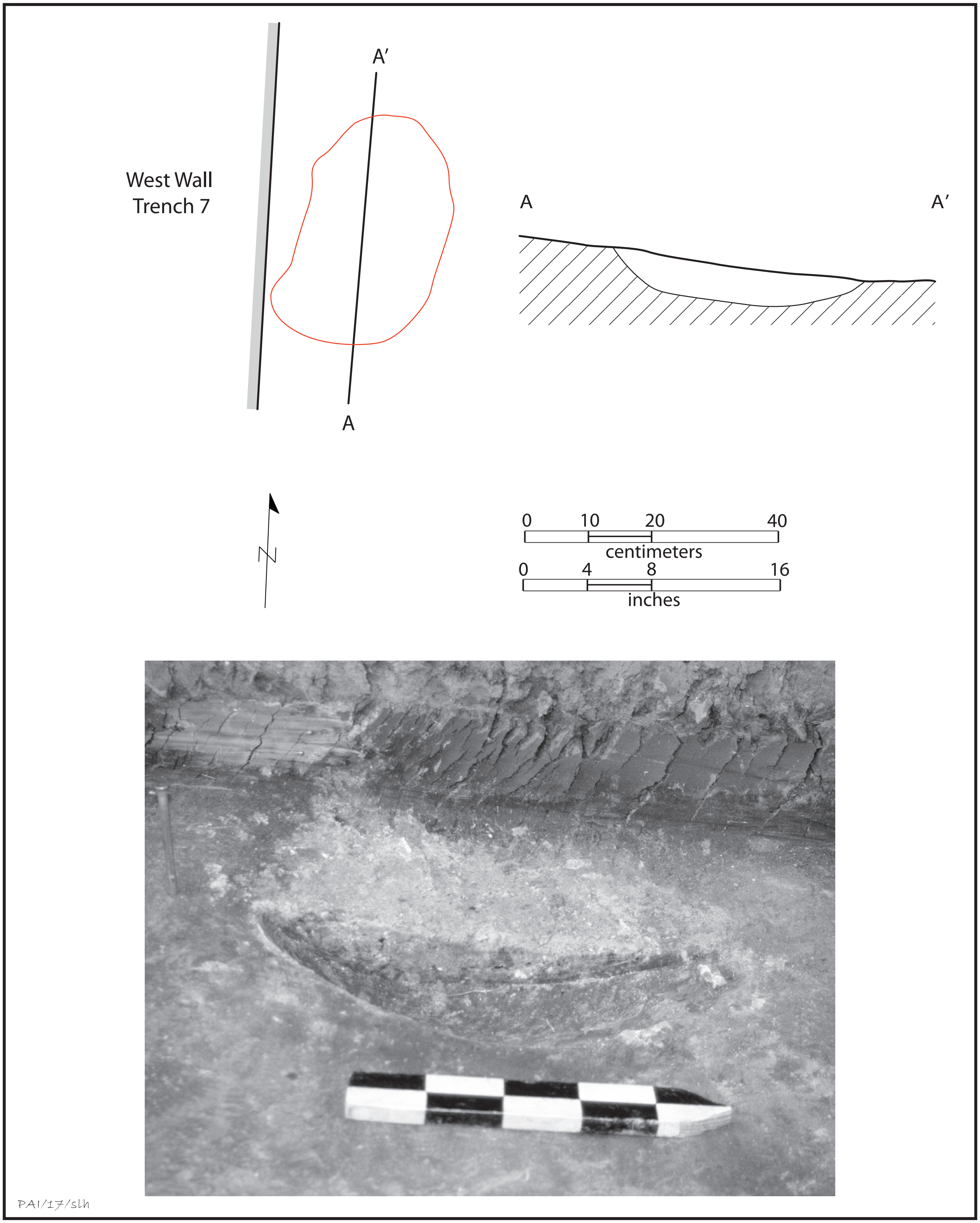


Figure 5.3. Plan, cross section, and photograph of Feature 4. Note abrupt contact between upper alluvial fill and paleosol just above the feature detection level in the Trench 7 wall.

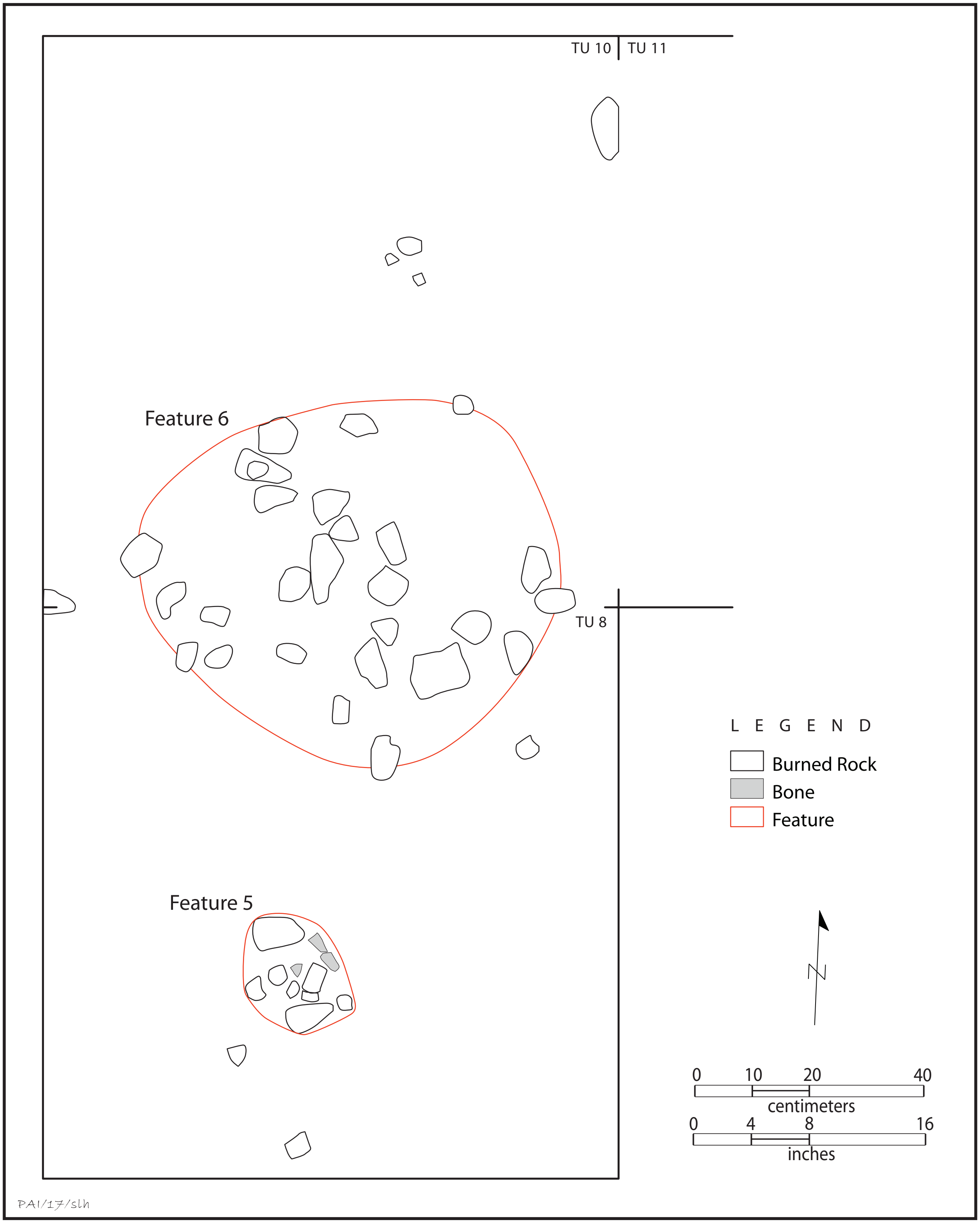


Figure 5.4. Plan of Features 5 and 6.

is 1–2 cm of the same matrix as the uppermost zone. No rocks were observed in the charcoal band or the lowermost fill. A total of 38 burned rocks were counted, weighing 6.6 kg (Figure 5.5). Five are less than 5 cm in maximum dimension, 29 are between 5 and 10 cm, and 4 are larger than 10 cm. The entire feature fill was collected for flotation. The heavy fraction contains 4 flakes, 102 indeterminate pieces of bone weighing 0.9 g (all less than 3 cm in size; 4 burned), 39.7 g of burned clay, and 0.4 g of charcoal. The light fraction yielded abundant charred botanical materials (105.24 g). Identified wood charcoal in the analyzed sample is hickory/pecan (0.75 g), hackberry (0.25 g), elm/hackberry (0.03 g), white group oak (0.03 g), and indeterminate hardwood (0.01 g). The sample also contains a single hawthorn seed. A sample of unidentified wood charcoal collected from the southeast quadrant (98.22 m elevation) produced a corrected radiocarbon age of 540±40 B.P. (UGA-13209), with has a calibrated two-sigma date range of A.D. 1307–1363/1386–1442. It is interpreted as a shallow earth oven or surface hearth.

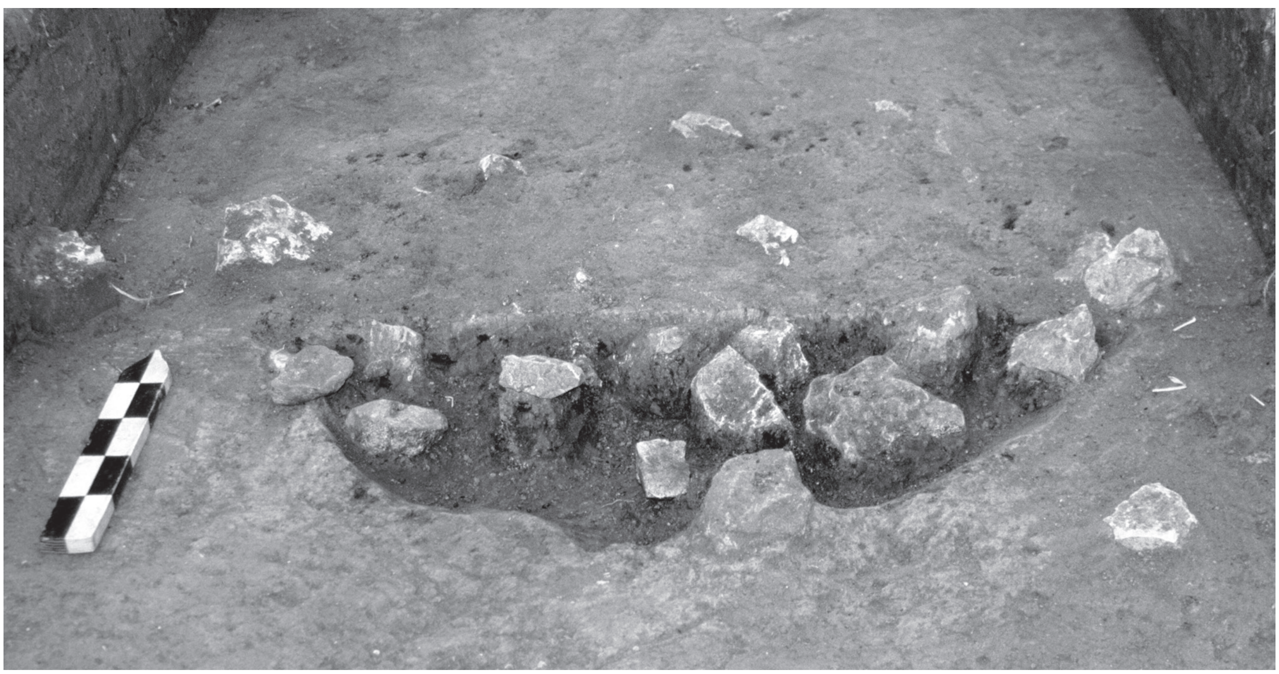


Figure 5.5. Photograph of Feature 6 cross sectioned. Note black charcoal in the feature fill.

Feature 7

Feature 7 is a mussel shell scatter in the southwest corner of Test Unit 8 at an elevation of 97.71–97.68 m. Its base is ca. 82 cm below the surface of the paleosol. The feature consists of 14 unburned freshwater mussel shells arranged in a single layer over an area 60 cm north-south by at least 26 cm east-west (Figure 5.6); its full western extent is unknown, as it goes into the wall of the test unit. One burned tabular piece of sandstone measuring 5 cm in maximum dimension and a small burned limestone rock were within this cluster. Scattered throughout the matrix surrounding the feature (Level 9) were an additional 23 unburned mussel shells and 63 burned rocks weighing 1.8 kg. The entire feature was collected for flotation. The heavy fraction contains 1 flake, 15 indeterminate pieces of bone weighing 0.2 g, 1 mussel shell, and 0.1 g of charcoal. The light fraction was not analyzed because charred botanical materials are sparse to absent. This feature represents materials discarded after a mussel-processing event.

Figure 5.6. Photograph of Feature 7 in southwest corner of Test Unit 8. Note scattered shells and burned rocks across the unit.

Feature 8

Feature 8 encompasses much of Test Unit 17, extending slightly into Test Unit 16. Its top and bottom elevations are 97.82 and 97.61 m, with its top coinciding with the surface of the paleosol. The feature is a large irregular basin containing burned rocks, abundant charcoal, and occasional small pieces of burned clay (Figure 5.7). In plan view, it is circular to oval measuring 120x93 cm; the maximum depth of the basin is 21 cm. A number of burned rocks appear to have fractured in situ. Charcoal is especially dense around the perimeter, also apparently reflecting in situ burning. The cross section reveals an upper zone 10–12 cm thick of very dark grayish brown silty to sandy clay loam with common charcoal and rare burned clay inclusions and burned rocks toward the bottom. Below this is a band of charcoal up to 8 cm thick containing pockets of ash, a few pieces of burned clay, and burned rocks. Burned rocks mapped and quantified in the field number 425, weighing 55.1 kg. Four are sandstone and the rest are limestone. The majority (n = 232) measure less than 5 cm in maximum dimension, 161 are between 5 and 10 cm, and 32 are larger than 10 cm. The largest measures 18 cm. Most rocks are blocky, but several are tabular.

The northern half was collected and screened through 1/4-inch-mesh hardware cloth. A ceramic sherd, 3 flakes, 1 unburned bison-sized long bone with a spiral fracture weighing 26.9 g (9–12 cm in size), and 1 mussel shell were collected. A second ceramic sherd found in Test Unit 17, Level 3, may also be associated with this feature. The southern half, apart from the many larger burned rocks, was collected for flotation. The heavy fraction contains 128 flakes, 133 pieces of bone weighing 35.6 g (all but 1 less than 3 cm in size; 107 burned), 6.2 g of charcoal, and 1.4 kg of burned rocks. Much of the bone (n = 107) is burned and consists of deer or deer-sized elements (n = 109); the remainder are indeterminate. The light fraction yielded abundant charred botanical material (59.32 g). Identified wood charcoal in the analyzed sample is elm (0.30 g), white group oak (0.18 g), hawthorn (0.13 g), dogwood (0.08 g), hickory/pecan (0.04 g), hackberry (0.01 g), and indeterminate hardwood (0.07 g). The light fraction also contains 0.03 g of charred Indian breadroot (*Pediomelum* sp.) tuber.

Two specimens of unidentified wood charcoal were hand collected. One taken from just southeast of the center (97.71 m elevation) produced a corrected radiocarbon age of 310±40 B.P. (UGA-13210), which has a two-sigma date range of A.D. 1470–1655. The other sample, taken from northeast of the center (97.70 m elevation), produced a corrected radiocarbon age of 460±60 B.P. (UGA-13211), which has a two-sigma date range of A.D. 1318–1352/1390–1525/1557–1633.

In the northeast corner of Test Unit 17, along the east wall just north of Feature 8, the edge of an ash lens was observed at an elevation of 97.83 m. Because it was not further defined, it was not given a feature designation. This ash lens could be associated with Feature 8. In fact, the large quantities of charcoal observed in Levels 2 and 3 of the test units adjacent to Test Units 16 and 17 also may be associated with Feature 8, or possibly Feature 9, which is ca. 60 cm south of Feature 8. Feature 8 is interpreted as a shallow earth oven or surface hearth.

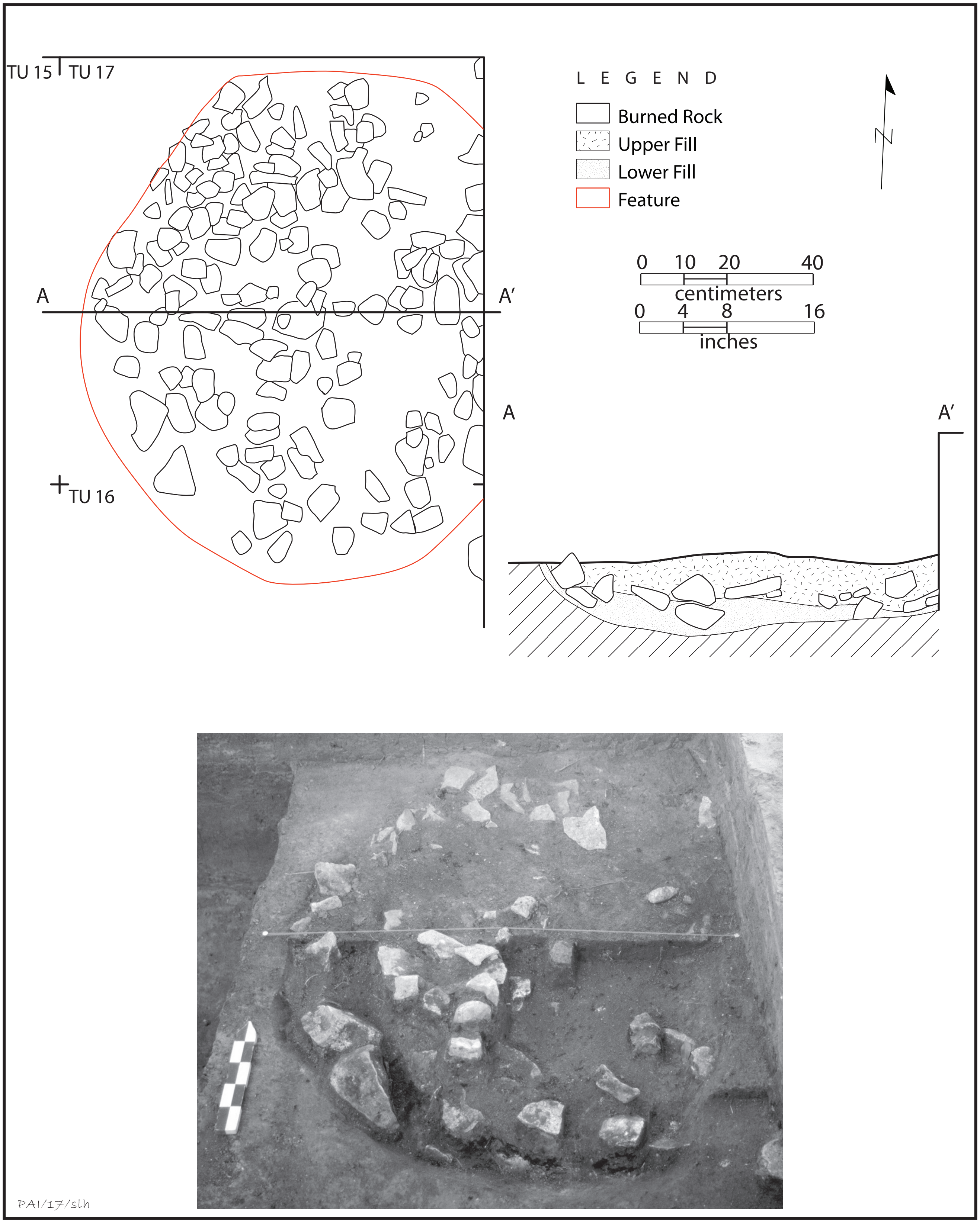
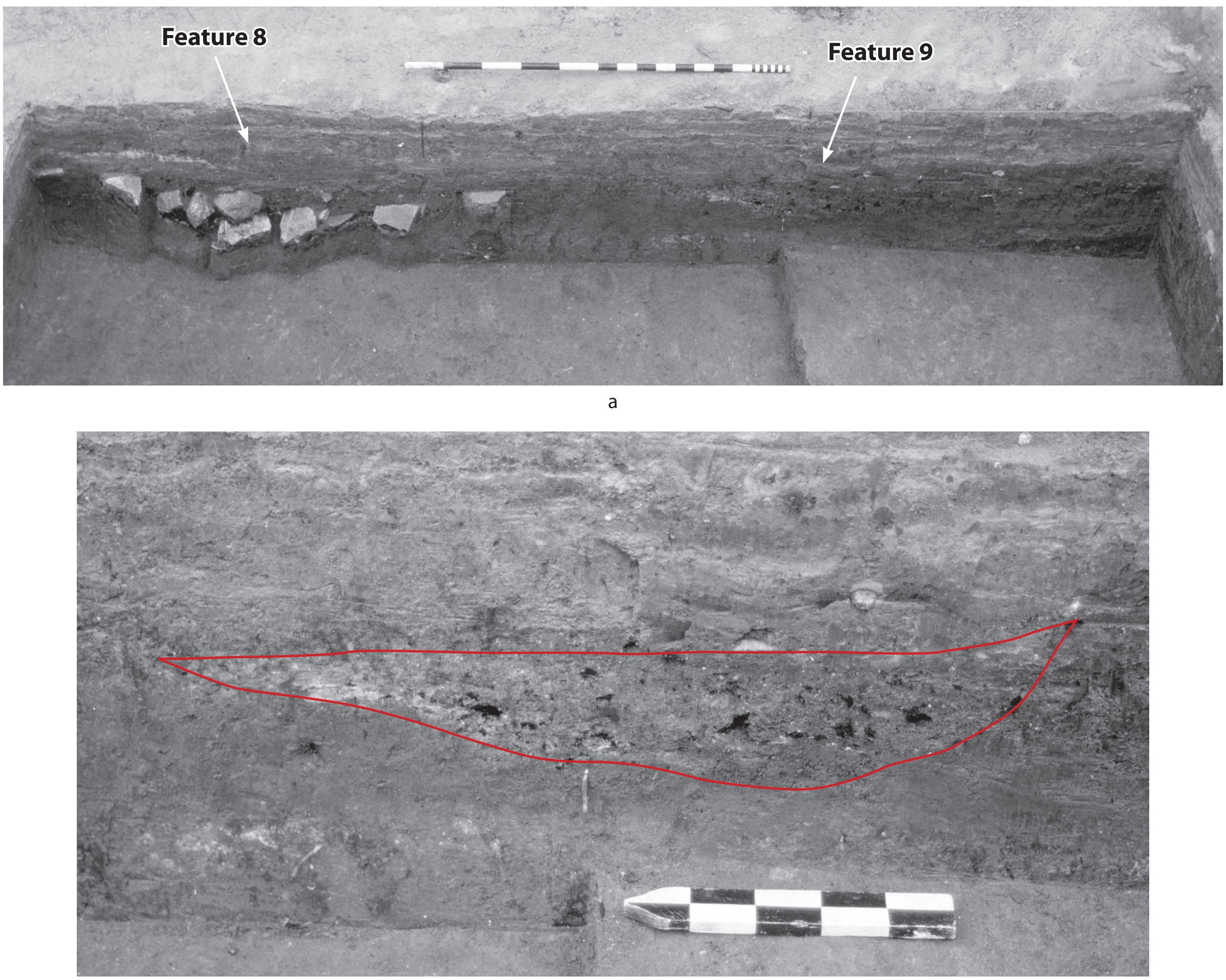


Figure 5.7. Plan, cross section, and photograph of Feature 8.

Feature 9

Feature 9 is a pit observed in the walls of the northeast corner of Test Unit 19 and the southeast corner of Test Unit 16 (Figure 5.8). The feature originally extended into these units but was not noticed during excavation and thus was observed only in profile. Its top and bottom are at elevations of 97.85 and 97.77 m, with its top coinciding with the surface of the paleosol. The feature is a small shallow basin measuring about 56 cm wide. Its fill is very dark grayish brown silty clay loam with charcoal and burned clay throughout. Charcoal was particularly noticeable along the bottom of the basin. A small pocket of possible ash was also observed in the northern part. No burned rocks or artifacts were observed in the profile. A sample of unidentified wood charcoal collected from the bottom produced a corrected radiocarbon age of 440±50 B.P. (UGA-13212) and a calibrated two-sigma date range of A.D. 1405–1524/1558–1632. Feature 9 is interpreted as an open hearth.



a

b

Figure 5.8. Photographs of Feature 9. (a) Overview of the east walls of Test Units 17, 16, and 19 (left to right) with Feature 8 on the left and Feature 9 in center right; (b) close up view of Feature 9 in the east walls of Test Units 16 and 19. Note that both features originate at the top of the paleosol.

Features from Data Recovery

Feature 10

Feature 10 is a pit in Excavation Unit 14, extending slightly south into Excavation Unit 13, at an elevation of 98.63 to 98.51 m (Figure 5.9). Its top is just beneath the surface of the paleosol. The feature is a shallow basin. In plan view, it appears as a circular cluster of burned limestone rocks ca. 72–78 cm in diameter. In cross section, it appears essentially as a single layer of rocks at the top, sitting on light brown silty clay loam fill containing charcoal and burned clay. Some of the rocks slope inward toward the center of the basin, and some appear to have been fractured in situ. Most are 10–15 cm in size. The total weight of the 48 burned rocks is 43.9 kg. Below the charcoal-rich fill in the bottom of the basin is ca. 5 cm of light brown silty clay loam. Significant quantities of burned clay and charcoal were scattered around the feature to its north, west, and particularly south. No artifacts were observed. The entire feature matrix was collected for flotation. The flotation sample yielded 108 indeterminate bone specimens weighing 3.0 g (all less than 3 cm in size; 3 burned). The light fraction yielded abundant charred botanical materials (43.22 g). The analyzed sample includes wood charcoal identified as elm (0.60 g), white group oak (0.33 g), soapberry (0.01 g), and indeterminate hardwood (0.10 g), along with an acorn nutshell fragment (0.01 g). Two samples of unidentified charcoal were collected for radiocarbon dating. These yielded corrected radiocarbon ages of 500±70 and 300±50 B.P. (UGA-15194 and UGA-15195), with calibrated two-sigma date ranges A.D. 1292–1520/1592–1620 and 1465–1666/1785–1795. Feature 10 is interpreted as a shallow earth oven or surface hearth.

Feature 11

Feature 11 is at the junction of Excavation Units 44, 45, 47, and 48. Elevations range from 97.83 to 97.75 m. The feature consists of a loose concentration of primarily bison and bison-sized rib (n = 41) and radius (n = 1) fragments in an area 1.3 m in diameter (Figure 5.10). The bones, which are not burned, represent a debris scatter lying on the paleosol surface. Other vertebrate fauna present are deer (1 tooth and 1 calcanium) and fish (1 vertebra). Many of the elements are nearly complete; their total weight is 545.4 g. The matrix was indistinguishable from the adjacent nonfeature matrix, a compact silty clay loam interspersed with sandy bands, charcoal flecks, and abundant hackberry seeds (not charred). Three small burned rocks and one flake were observed in the surrounding sediments, which were collected for flotation. The flotation sample yielded sparse charred botanical materials (1.33 g), which include wood charcoal identified as white group oak (0.07 g), unspecified oak (0.01 g), and hawthorn (0.01 g), as well as four indeterminate seeds (0.01 g). The flotation sample also yielded 111 bones weighing 2.3 g and consisting of 1 fish vertebra, 2 turtle femurs, and 108 indeterminate specimens (all less than 3 cm in size; 3 burned). Two unidentified charcoal samples for dating were collected from the surrounding matrix. These samples yielded corrected radiocarbon ages of 530±60 and 290±50 B.P (UGA-15196 and UGA-15197), which have calibrated two-sigma date ranges of A.D. 1295–1454 and 1458–1670/1781–1799/1945–1949.

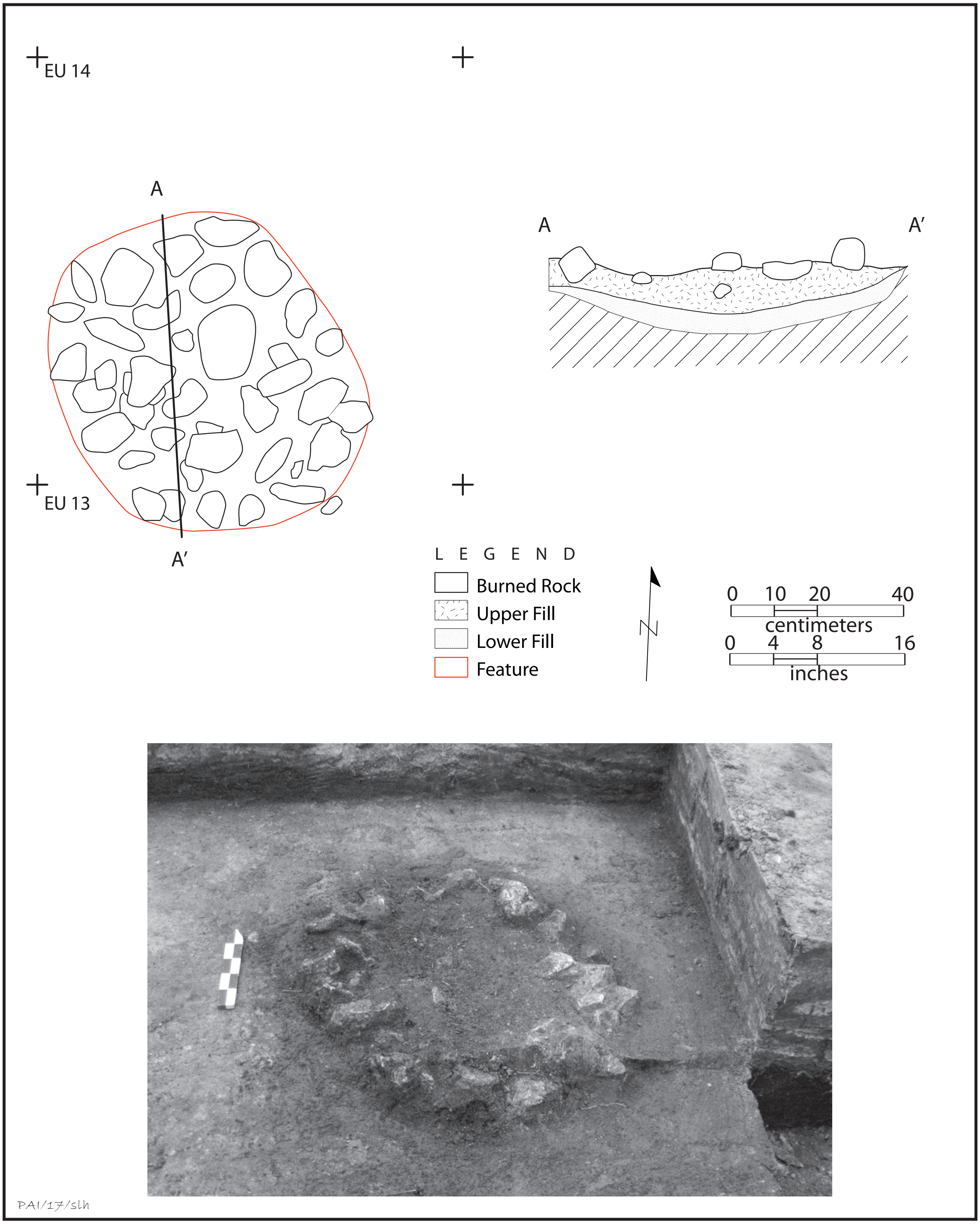


Figure 5.9. Plan, cross section, and photograph of Feature 10. Photograph taken before deeper central rocks were exposed. Note laminated upper alluvial unit overlying the feature and paleosol in unit walls to the right.

Figure 5.10. Plan of Feature 11.

Feature 12

Feature 12 is a scatter of 80 unburned freshwater mussel shells (weighing 309 g) that is most concentrated in Excavation Unit 28 but extends south into the northern portions of Excavation Units 81 and 82 and east into Excavation Units 25 and 27 (Figure 5.11); it also likely extends west beyond the block. It covers an area of 2.5 m north-south by at least 2.0 m east-west. The western and southern parts are at elevations of 98.10–98.11 m, and the eastern and northeastern parts dip to 97.92 m. It generally parallels the paleosol surface but is 18–23 cm below it. The matrix surrounding the shells is similar to the surrounding nonfeature matrix, gray to brownish gray silty clay loam with moderate charcoal inclusions. Associated artifacts include a Perdiz arrow point, one flake, and three pieces of burned limestone 6–8 cm in size and weighing 0.3 kg. The matrix immediately around and below the shells was collected for flotation. This sample yielded 6.57 g of charred botanical materials, including white group oak (0.04 g), elm (0.02 g), hickory/pecan (0.01 g), mulberry (0.01 g), and blackhaw (0.01 g) wood charcoal, as well as 2 snake vertebrae and 96 indeterminate vertebrate faunal specimens weighing 0.7 g. Two unidentified charcoal samples (one hand collected and one from flotation) produced corrected radiocarbon ages of 430±50 and 660±50 B.P. (UGA-15198 and UGA-15204), with calibrated two-sigma date ranges of A.D. 1410–1525/1557–1633 and 1270–1401.

Feature 13

Feature 13 is in the northeast quadrant of Excavation Unit 85. It is an oval cluster of two burned rocks, two chert flakes, five unburned deer or deer-sized long bone (with spiral fracture) and rib elements weighing 31.2 g (one less than 3 cm in size, one 3–6 cm, and three 6–9 cm), a Perdiz point, and one burned tabular sandstone grinding slab fragment in an area of 35x25 cm (Figure 5.12). The top and bottom elevations are 97.80 and 97.70 m, respectively. The artifacts appeared to be lying flat, roughly on the paleosol surface. The feature is interpreted as a discard pile rather than an intact cooking or heating feature, although the feature matrix exhibited more charcoal flecking and staining than the surrounding nonfeature matrix; this charcoal-rich matrix extended north from the feature for a distance of ca. 10 cm. The three burned rocks measured 6–23 cm in maximum dimension and weighed 1.8 kg. The matrix under the feature was collected for flotation. The light fraction yielded a small amount (0.13 g) of charred botanical materials including white group oak (0.02 g), mulberry (0.01 g), and indeterminate hardwood (0.01 g) charcoal and pecan nutshell fragments (0.04 g). Vertebrate fauna from the flotation sample consist of 97 indeterminate specimens weighing 2.3 g (all less than 3 cm in size; 3 burned). Two unidentified charcoal samples (one hand collected and from the flotation sample) produced corrected radiocarbon ages of 210±50 and 510±40 B.P. (UGA-15199 and UGA-15205), with calibrated two-sigma date ranges of A.D. 1524–1559/1631–1710/1717–1890/>1910 and 1318–1352/1390–1450.

Feature 14

Feature 14 is a shallow basin-shaped pit in the western portions of Excavation Units 145 and 153. The top and bottom elevations are 97.62 to 97.55 m,

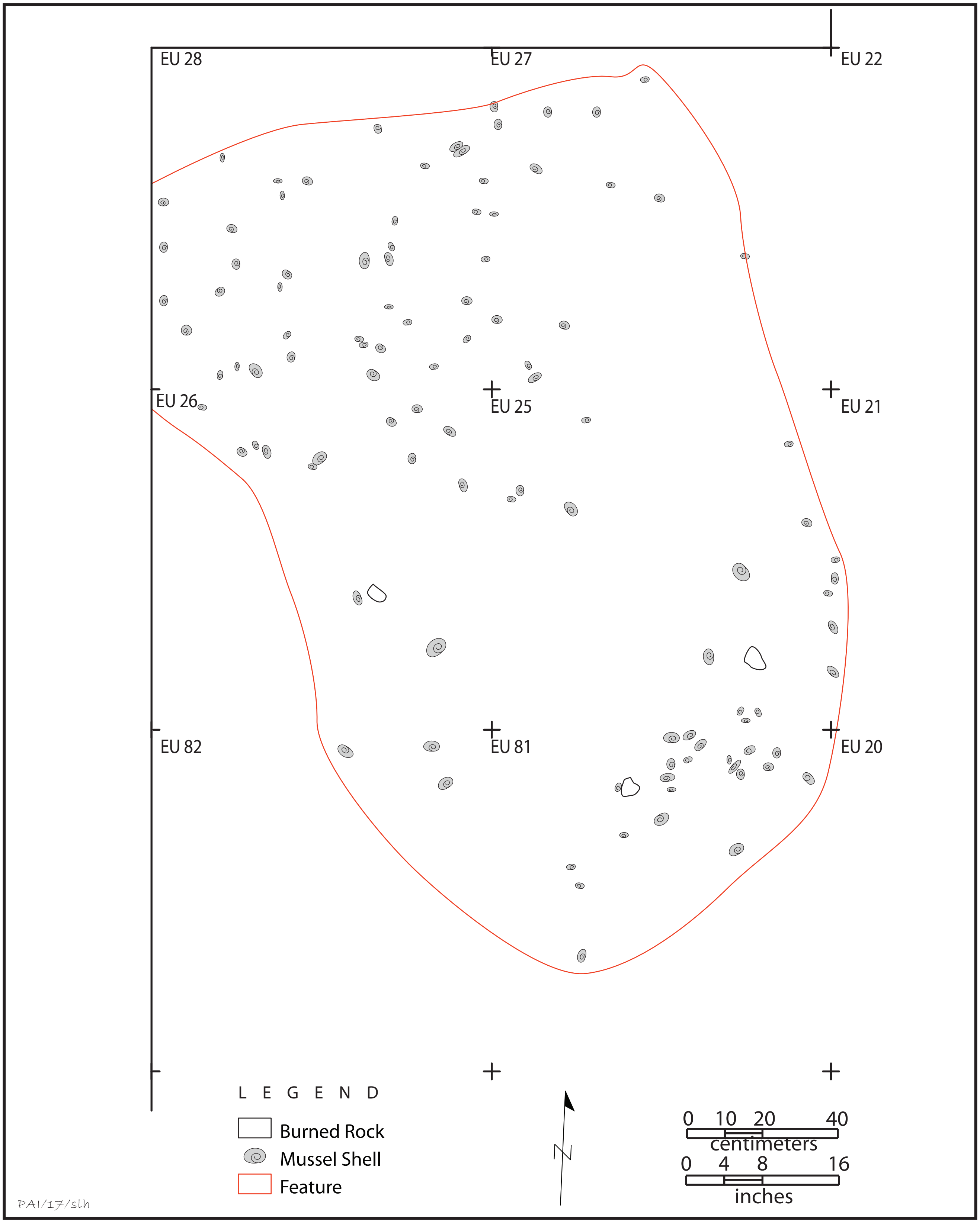


Figure 5.11. Plan of Feature 12.

Figure 5.12. Photograph of Feature 13.

with the former corresponding to the paleosol surface. In plan view, it is circular with a diameter of 22 cm (Figure 5.13). A tree root disturbs the north and northeast sides. In cross section, a thin cap of ash less than 1 cm thick sits atop 6–7 cm of pit fill consisting of light brownish yellow and then brown to dark brown burned clay/oxidized sediment. A bison tibia fragment lay just above the northern part of the feature. No lithic artifacts were observed. The entire feature matrix was collected for flotation. The light fraction yielded 2.22 g of charred botanical material, including elm (0.12 g), hickory/pecan (0.01 g), mulberry (0.01 g), and indeterminate hardwood (0.02 g) charcoal and a charred sedge seed (0.01 g). The flotation sample also yielded 4 snake vertebrae and 63 indeterminate bone specimens with a total weight of 1.6 g (all less than 3 cm in size; none burned). Two unidentified charcoal samples (one hand collected and one from the flotation sample) produced corrected radiocarbon ages of 400±50 and 380±40 B.P. (UGA-15200 and UGA-15206) with calibrated two-sigma date ranges of A.D. 1428–1530/1539–1635 and 1441–1530/1540–1635. Feature 14 is interpreted as an open hearth.

North and south of the feature for distances of 2 m are a number of bison and bison-sized bones scattered on the paleosol surface (Figure 5.14). These consist of rib (n = 17) and metatarsal (n = 1) fragments. Other faunal specimens include fish (2 skull fragments). Several burned rocks are also interspersed among these bones.

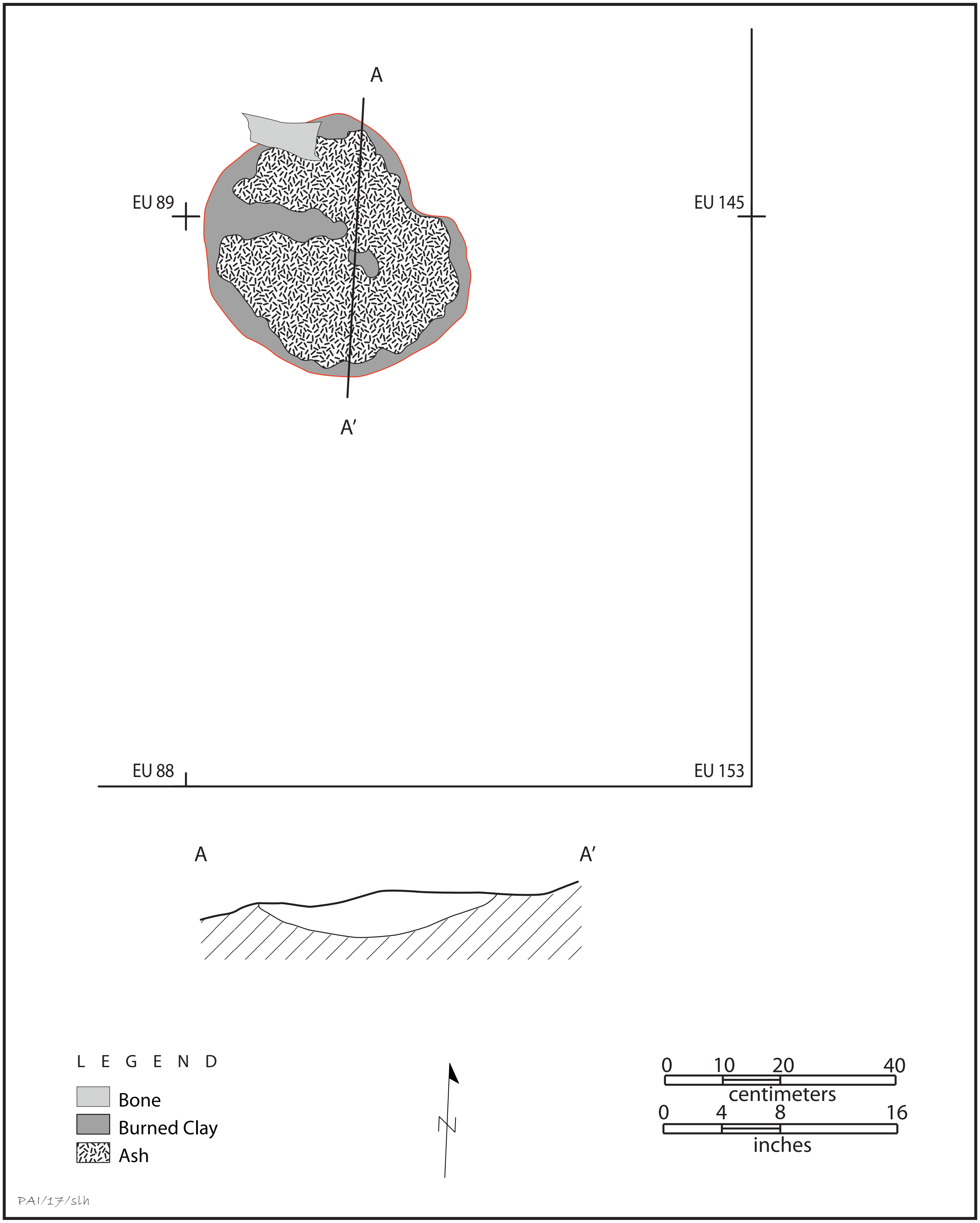


Figure 5.13. Plan and cross section of Feature 14.

Figure 5.14. Photograph facing northeast showing Feature 14 (capped by light-colored ash) in right center and bison and bison-sized bones nearby. Note laminated upper alluvial unit overlying the feature and paleosol in unit walls to the right.

Feature 15

Feature 15, a concentration of discarded animal bones, is mostly in Excavation Units 96 and 97, extending slightly into the southeastern corner of Excavation Unit 133. Top and bottom elevations are 97.56 and 97.46 m, with the bones sitting in the uppermost part of the paleosol. The concentration covers an area of 50x33 cm and contains 353 unburned fragments (total weight = 321.5 g) of deer skeletal elements representing a calvarium with antlers, mandible, and lower leg elements (including tibia, astragalus, metatarsal, metapodial, sesamoid, and phalanges) (Figure 5.15) The vast majority (n = 325) are less than 3 cm in size, with 25 being 3–6 cm, 2 being 6–9 cm, and 1 larger than 9 cm. No artifacts were associated with the feature, although a fair amount of charcoal was present in the underlying sediments. One sample of unidentified charcoal was collected for dating and yielded a corrected radiocarbon age of 690±50 B.P. (UGA-15201), with a calibrated two-sigma date range of A.D. 1257–1324/1346–1394.

Feature 16

Feature 16 is mostly in Excavation Unit 156 and extends slightly north into Excavation Unit 152. Top and bottom elevations are 98.50 and 98.39 m, with its top at the sloping (down to the north) surface of the paleosol. In plan view, the feature

Figure 5.15. Photograph of Feature 15 partially exposed.

appears as a loose, but discrete, oval cluster of burned rocks measuring 80x50 cm (Figure 5.16). Additional burned rocks occur beyond the feature boundaries to the east and especially north. The cross section shows a shallow basin ca. 10 cm deep with a single layer of rocks and an underlying mixed layer of dark brown silty loam sediments and abundant charcoal. Burned rocks number 25 weighing 5.2 kg; 6 rocks are 0–5 cm in maximum dimension, 13 are 5–10 cm, and 6 are 10–15 cm. A few rocks sloped down toward the center of the feature and appear to have fractured in place. Approximately 47 burned rocks weighing 7.1 kg are scattered across Excavation 143, 144, 152, and 155 to the north and northeast. Most measure less than 10 cm in maximum dimension, but 3 are 10–15 cm. These rocks probably originated in the feature but were either cleaned out of it or, less likely, moved through natural forces. No artifacts were observed in the feature. The entire feature matrix was collected for flotation. The light fraction yielded abundant (121.73 g) charred botanical material, including wood charcoal identified as white group oak (0.50 g), elm (0.38 g), mulberry (0.14 g), ash (0.09 g), blackhaw (0.07 g), hickory/pecan (0.05 g), and indeterminate hardwood (0.03 g). Vertebrate fauna from the flotation sample consist of 48 indeterminate

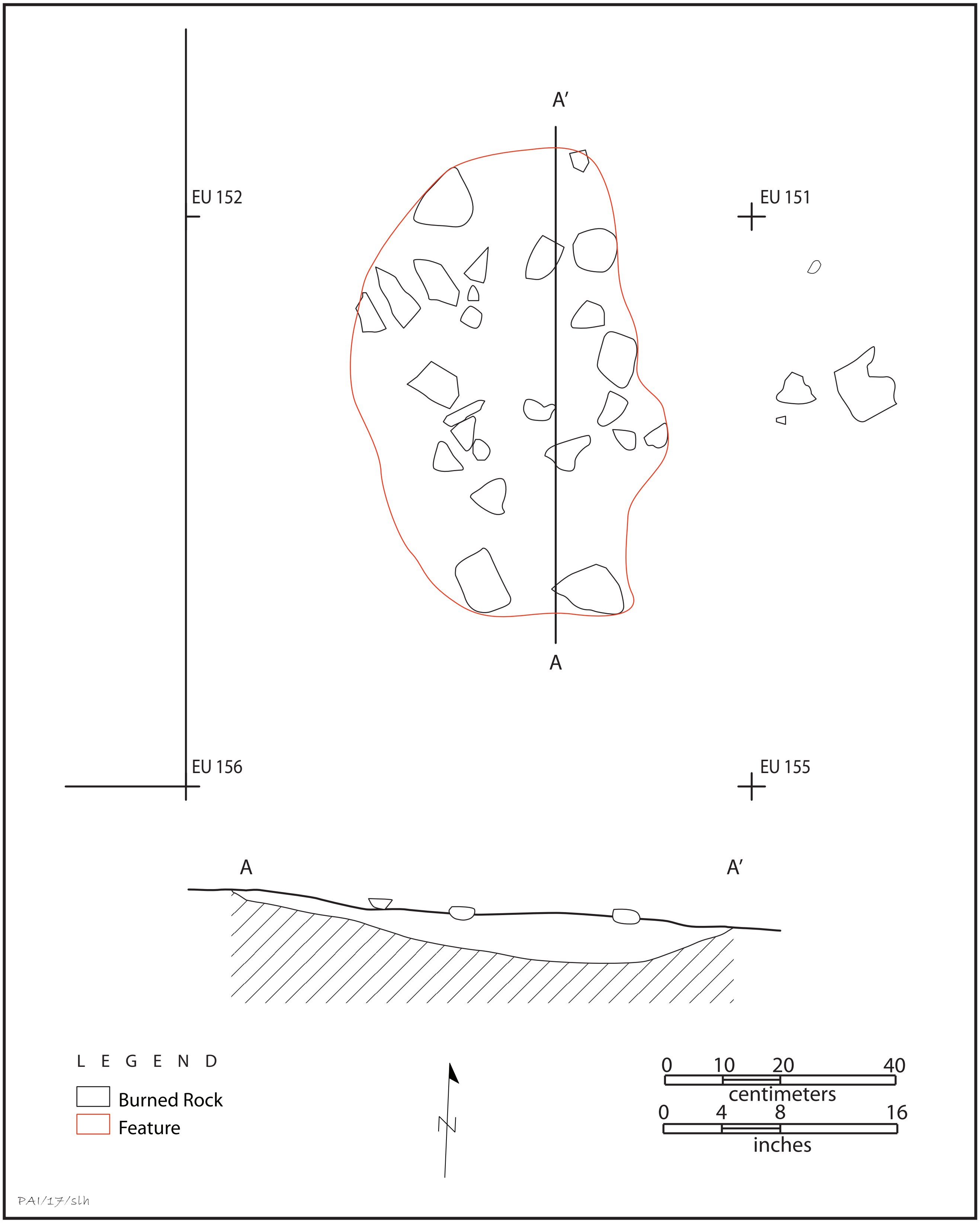


Figure 5.16. Plan and cross section of Feature 16.

specimens weighing 0.3 g (all less than 3 cm in size; none burned). Three charcoal samples were submitted for dating; they yielded corrected radiocarbon ages of 480±40 and 500±50 B.P. (UGA-15202 and UGA-15203), with calibrated two-sigma date ranges of A.D. 1327–1343/1394–1476 and 1307–1363/1385–1477. Feature 16 is interpreted as a shallow earth oven or surface hearth.

Feature 17

Feature 17 is just west of the center of Excavation Unit 136. Top and bottom elevations of are 97.69 and 97.63 m. The feature consists of a roughly oval cluster of five burned rocks and three chert flakes measuring 35 cm north-south and 20 cm east-west and resting on the surface of the paleosol (Figure 5.17). The rocks are 4–7 cm in maximum dimension; their weight was not recorded but is estimated

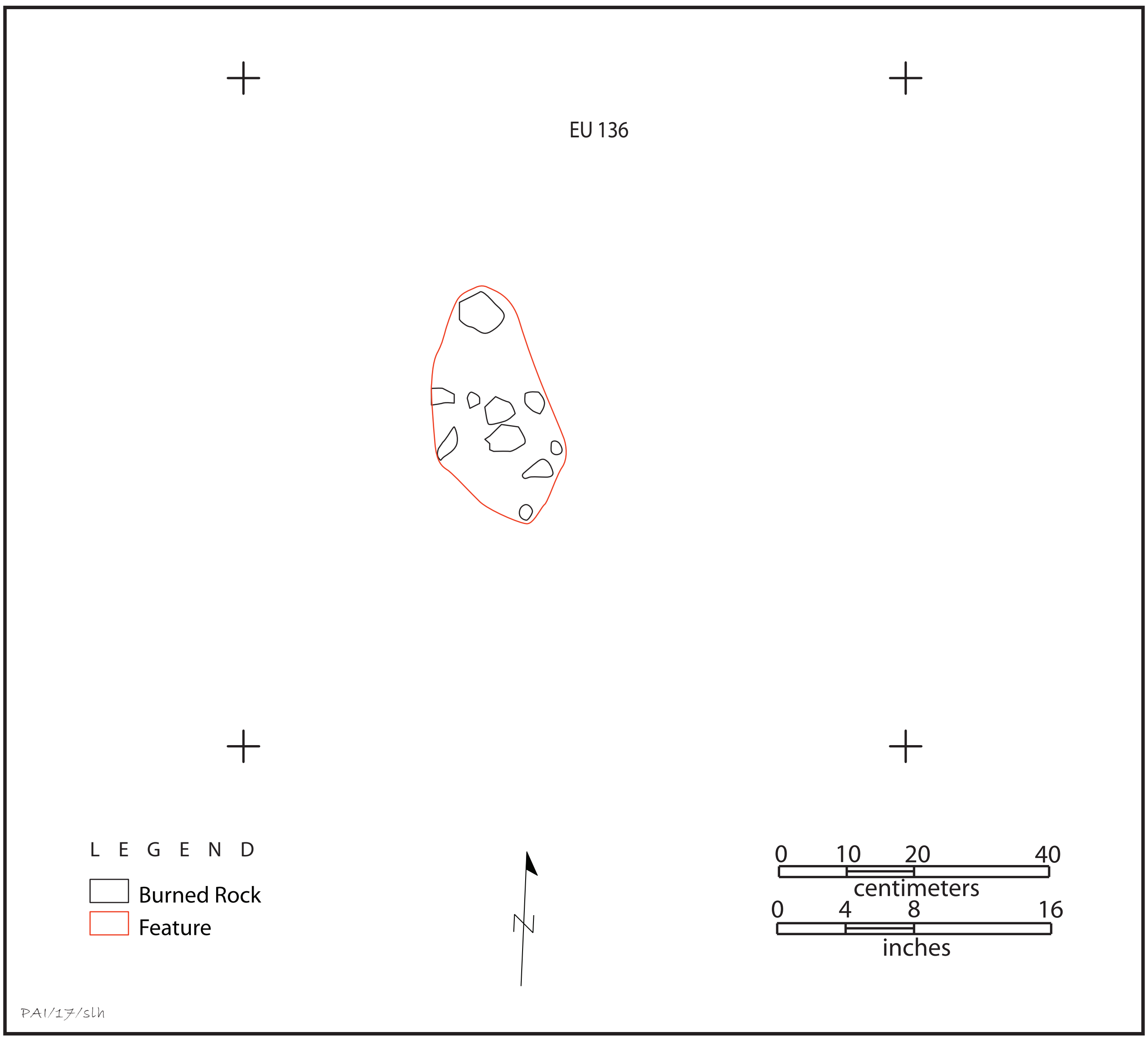


Figure 5.17. Plan of Feature 17.

to have been 1.7 kg (based on comparable concentrations that were weighed). This appears to represent a discard pile of spent hearth or earth oven stones. The sediments around the rocks were collected for flotation. The light fraction yielded 2.69 g of charred botanical material, including wood charcoal identified as white group oak (0.02 g), hickory/pecan (0.02 g), and indeterminate hardwood (0.01 g). Vertebrate fauna from the flotation sample consist of 3 fish skull fragments and 31 indeterminate fragments weighing 2.2 g (all less than 3 cm in size; none burned).

Feature 18

Feature 18 is in Excavation Unit 145 at an elevation of 97.60 to 97.50 m. This elevation puts it immediately below the paleosol surface. The feature is a lithic knapping area consisting of 45 flakes representing the late-stage reduction and sharpening of a single tool based on the similar light brownish gray color and texture of the chert material and the presence of two sets of 2 flakes that refit. All of the striking platforms that are intact are multifaceted and well ground. Most are small tertiary flakes lacking dorsal cortex, although a limited amount of cortex is present on 2 flakes. These are the only cultural materials recovered from this provenience. This feature was not recognized during excavation, so it is unknown how the flakes were actually distributed.

THE LITHIC ASSEMBLAGE

The lithic assemblage consists of cores, debitage, flaked stone tools, ground and battered stone tools, and fragments of potential pigment stones. Included are 322 chipped tools and tool fragments, 26 cores and core fragments, 6,589 pieces of unmodified debitage, 19 ground and battered stone artifacts, and 38 fragments of potential stone pigment sources (Table 5.2). The analysis presented here is mostly descriptive, with an emphasis on understanding the technologies used. Interpretations based on context are presented in Chapter 6.

Table 5.2. Summary of the lithic assemblage

Artifact Category	Total
Cores and fragments	26
Debitage	6,589
Flake and blade tools	95
Convex end unifaces	17
Other unifaces	21
Drills, perforators, and gravers	15
Chopping tool	1
Bifacial and beveled knives	20
Other bifaces and fragments	47
Darl dart point	1
Ensor dart point	1
Cuney arrow point	1
Harrell/Washita arrow point	1
Perdiz arrow points and preforms	55
Scallorn arrow point	2
Untyped arrow points and preforms	45
Hammerstones	8
Anvils and slabs	5
Manos	3
Polishing/burnishing stone	1
Indeterminate ground stone fragments	4
Potential pigment stones	38
Total	6,996

Of the chipped stone tools, 116 (36 percent) are simple-detachment based, 96 (30 percent) are complex-detachment based, and 110 (34 percent) are core-based tools. Simple-detachment tools are flakes and blades removed from cores and used with no or modest secondary modification. Complex-detachment tools typically underwent significant modification during manufacture prior to use but have technological indications of their flake or blade origin (e.g., ventral surface, bulb of percussion, striking platform, or portions of these). Core-based implements are constructed from cores rather than detached flake or blade blanks, or the type of detachment (flake or blade) cannot be determined. The similar proportions of each manufacture technique are not surprising given the nature of the assemblage and the cultural features present, which suggest a diverse array of tasks and activities at the site.

Chipped tools are assigned to one of four basic forms: biface (n = 165, 52 percent), blade (n = 33, 10 percent), flake (n = 86, 27 percent), and other nonbiface (n = 36, 11 percent). Among these general tool forms are formal and informal modified and unmodified tools. Bifacial tools are classified as formal or informal, and flake, blade, and other nonbifacial tools are assigned to modified and unmodified groups. A small number of tools could not be assigned to any of these four groups and are considered indeterminate.

Raw Materials

Chert is the overwhelmingly predominant raw material. The only nonchert artifacts are 7 items (5 flakes and 2 refitting arrow point fragments) of obsidian, 12 quartzite artifacts (3 flakes, 8 hammerstones, and 1 polishing stone), 10 items of sandstone (4 slab fragments, 3 manos, and 3 indeterminate ground stones), 2 limestone artifacts (an anvil and an indeterminate ground stone), and 38 mostly limonite/ocher/hematite pigment stones. Identifying the specific varieties of chert present in the assemblage is problematic because of the degree of homogeneity of the materials. The assemblage is dominated by varying shades of gray, dark gray, brownish gray, tan, and tannish gray, which account for 80–90 percent of all artifacts. Some of these colors are broadly comparable with chert materials identified at Fort Hood in Bell and Coryell Counties. Representative colors are N4, N5, N6, 5YR4/1, 5YR6/1, 5Y8/1, N9, and 5B9/1 (using Munsell Rock Color Chart nomenclature). Based on cortex character, the procurement environments included riverine (stream-rolled battered cortex), upland lag deposits (weathered and pitted cortex with staining), and bedrock outcrops (unweathered or only slightly weathered chalky cortex).

Rather than attempt a detailed analysis of color, texture, and other physical properties to assess the range of cherts present, an ultraviolet fluorescence (UVF) study was done to provide baseline information on the geological origins of artifacts and debitage (conclusions of this study in terms of mobility and procurement strategies are presented in Chapter 6). Ultraviolet fluorescence has become a proven expedient and inexpensive technique for distinguishing among different lithic sources that are otherwise visually similar (Frederick et al. 1994; Hillsman 1992; Hofman et al. 1991; Newlander and Speth 2009). The chert type collection at the Prewitt and Associates lab was used as a reference during the analysis and as a comparative sample. Prior to the study, the analyst familiarized himself with fluorescence color variation of cherts in that collection, including samples from the Texas Panhandle, west Texas, central Texas, and southwest Texas. Additional samples were obtained from a survey of raw materials within the upper Leon River basin and were included as comparative material for the archeological assemblage (Table 5.3). The methods used in this analysis are presented in Chapter 2 (Analysis Methods, Lithics).

Table 5.3. Raw material samples used as reference materials for the UVF study of chipped stone tools and debitage

Raw Material	UV color	Reference
Texas Panhandle materials	Green, dark green, pale green, banded green	literature*
Alibates (Potter County)	Green, pale green, dark green, banded green	hand specimens and literature*
Edwards cherts	Yellow to orange	hand specimens and literature*
Winchell limestone materials (Pennsylvanian)	Deep purple, dark purple, purple-brown	hand specimens
Ranger limestone materials (Pennsylvanian)	Deep purple; fusilinids fluoresce white	hand specimens
Cretaceous-age streambed gravels from the upper Leon River basin	Yellow to orange	hand specimens
Tecovas (Potter County)	Pale green to banded green	hand specimens
Potter chert (Potter County)	No fluorescence in gray sample available for analysis	hand specimens
Ogallala quartzites (Garza County)	No fluorescence in dark specimens; pale to white specimens fluoresce light to medium green similar to Alibates and Tecovas materials	hand specimens
Black to dark gray, microfossils (Bosque County)	Yellow to orange	hand specimens
Lake Alan Henry chert samples (Garza and Kent Counties)	Bright green, bright green with occasional bright orange blebs, pale green	hand specimens
Caballos novaculite/Maravillas chert (Brewster County)	Medium purple to deep purple	hand specimens
Chert cobbles from Pecos and Brewster Counties	Pale yellow to medium yellow	hand specimens

* Hillsman 1992; Hofman et al. 1991; Newlander and Speth 2009

Previous UVF studies of Cretaceous-age cherts from central Texas, particularly Edwards cherts, demonstrate that they consistently fluoresce between yellow and orange under both short-and long-wave UV light (Frederick et al. 1994; Hofman et al. 1991; Newlander and Speth 2009). Examination of all the tools and debitage from 41HM51 confirmed that the assemblage is dominated by Edwards Group cherts with short-wave UV fluorescence ranging from yellow to yellow–orange to orange. Even the presumably nonlocal Harrell/Washita arrow point fluoresces as Edwards Group chert. As Frederick et al. (1994:15) note for Fort Hood, the vast majority of the artifacts of Edwards cherts have UV colors incorporated within Munsell color sheets 5Y and 2.5Y. Heavily burned specimens have color ranges toward orange or orange–red. They also note that some cortex appeared to fluoresce orange or purple, but this was not consistently recorded as part of the analysis. Quartzite materials did not fluoresce.

Only a few artifacts did not fluoresce as Edwards Group chert. A battered chopping tool exhibits a deep purple fluorescence with occasional bright white fossil fragments. This artifact exhibits a weathered surface cortex indicating that it is from a drainage and not from a primary geological outcrop. Two pieces of debris also have a similar color: a coarse-grained gray chert shatter fragment and a fine-grained gray-black flake fragment with white microfossils. These three artifacts may represent Pennsylvanian cherts from the Ranger and Winchell Formations, which crop out in the upper Leon River basin (and north and northeast of the basin) northwest of the site.

There was little difference among these three artifacts in terms of long- and short-wave UV light. A single small retouch flake of fine-grained black chert did not fluoresce and may represent a piece of Owl Creek Black chert. Frederick et al. (1994:15) indicate that, of all the bedrock sources of chert that crop out near Fort Hood, only Owl Creek Black chert does not fluoresce. Only four pieces of material could be qualitatively identified as possibly originating within the Bosque River drainage to the east-southeast. This material is dark gray to black with occasional white microfossils and fluoresces like Edwards group chert (Mehalchick and Kibler 2008:355–356, Figure 9.4d–f).

All seven obsidian artifacts were sourced to the Jemez Mountains in New Mexico, however, two distinct localities are represented, the Cerro Toledo Rhyolite and the Valles Rhyolite (Appendix g). The point and one of the flakes are from the Valles Rhyolite source, and the other flakes are from the Cerro Toledo Rhyolite source. Shackley (2005) notes that the geographic distribution of these sources dictated how they could be procured. The collapse of the Cerro Toledo caldera and ash flows meant that material could be procured from Rio Grande alluvium, but the Valles Rhyolite obsidian had to be procured directly from the Cerro del Medio caldera.

Cores

A total of 26 cores and core fragments were recovered. Cores are defined as parent pieces of cryptocrystalline raw material that served as sources of flakes and blades for other tools (Whittaker 1994:14). Three basic trajectories for core reduction are represented at the Jayroe site: flake, blade, and biface. A core can serve as the basis for making expedient flakes or can be specifically prepared to produce specialized flakes such as blades, or it can be the object of manufacture itself, as in bifacial tools (Odell 2004:91). Flake and blade core technology are discussed here, whereas bifacial technology is discussed as part of the biface tool portion of the assemblage.

Of the 26 cores and fragments, 22 (85 percent) were flaked for the purpose of producing expedient flake blanks for unmodified and modified/formal tools. Only 4 (15 percent) are indicative of blade manufacture at the time of discard, even though there is additional evidence of blade use represented in the tools and debitage. Apparently, some blade cores were either completely reduced, carried away, or transformed into tools or other types of cores after blade manufacture. Alternatively, some blades may have been produced away from the site. None of the cores exhibit any type of specially prepared platforms, and none are abraded. Striking platform technology represented is largely related to changing reduction intensity, basically transitioning from cortex or single-faceted platforms to multifaceted platforms or combinations of these types.

Core morphologies are influenced by the size and shape of the raw materials, strategies for flake production (desired shapes/sizes of tool blanks), and reduction intensity. Blade production is represented by one blade core, one cobble/pebble core, and two probable blade core fragments (Figure 5.18). Flake production is represented by nine bifacial or discoidal cores (Figure 5.19), two each of tested cobble/pebble and partial cobble/pebble cores, and single macroflake (Figure 5.20a), microflake (Figure 5.20b), and noncortical cores. There are also six fragmentary flake cores. Blade cores

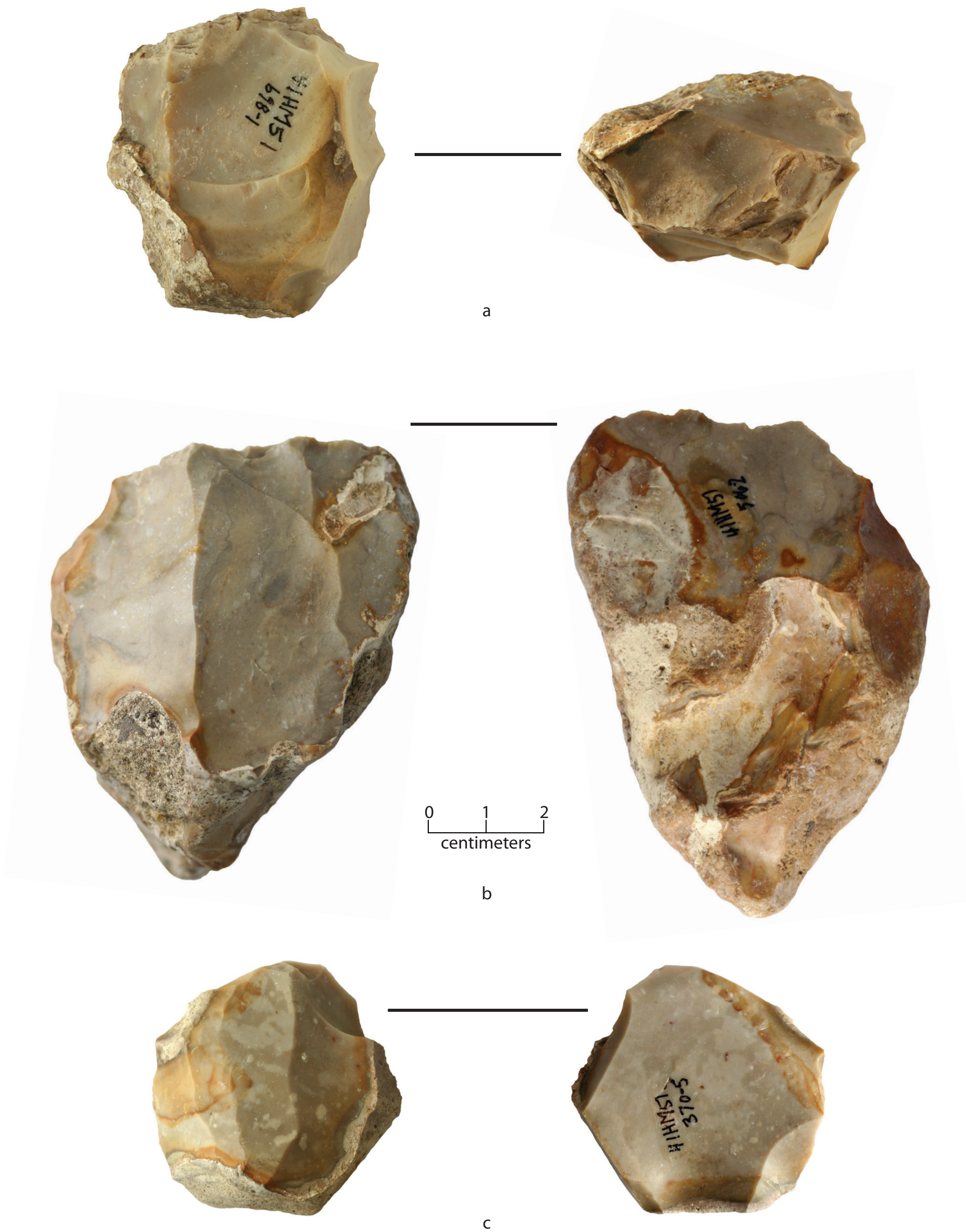


Figure 5.18. Blade cores (a–b) and blade core fragment (c) reflecting blade production.

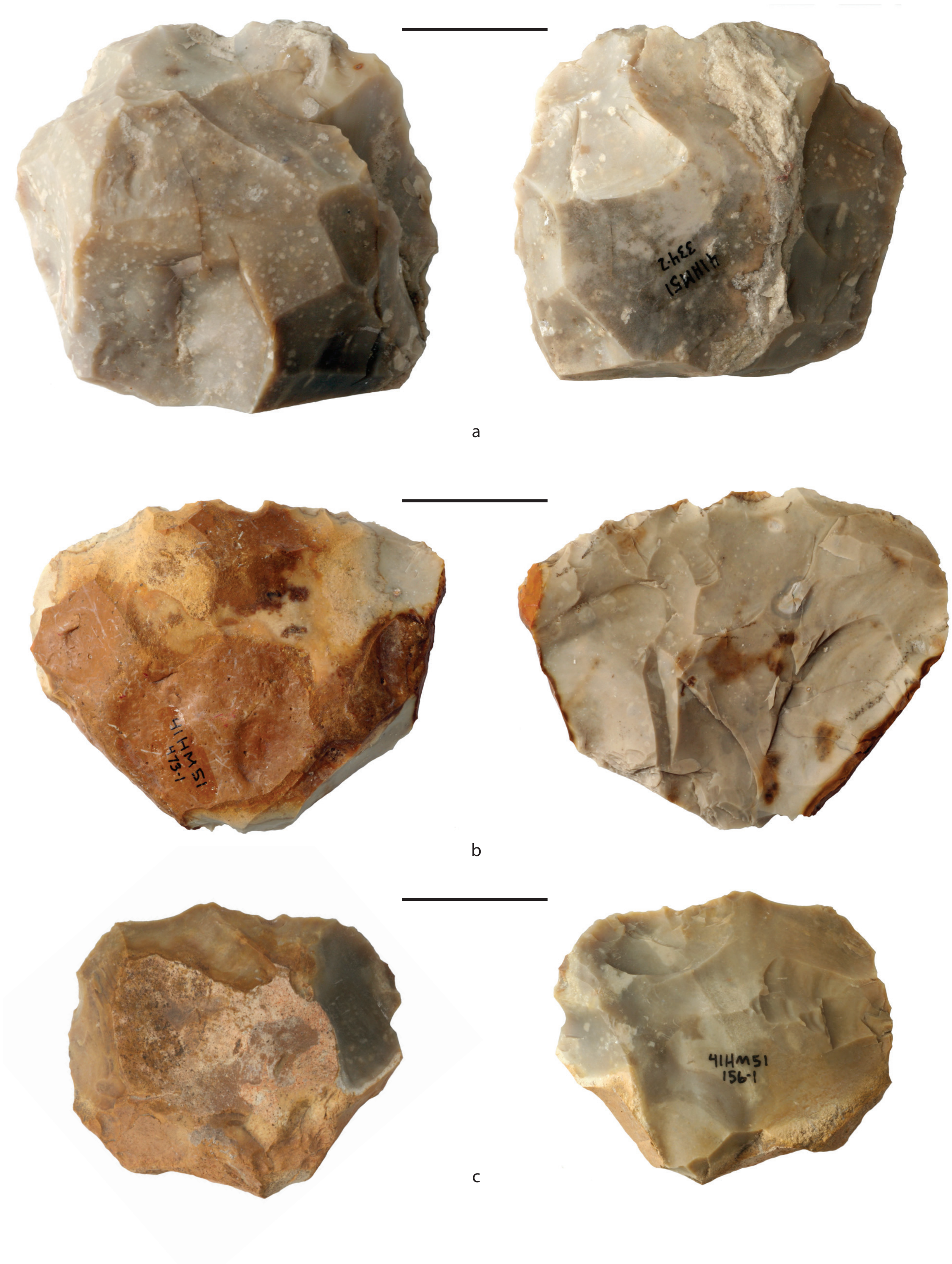


Figure 5.19. Bifacial or discoidal cores reflecting flake production.

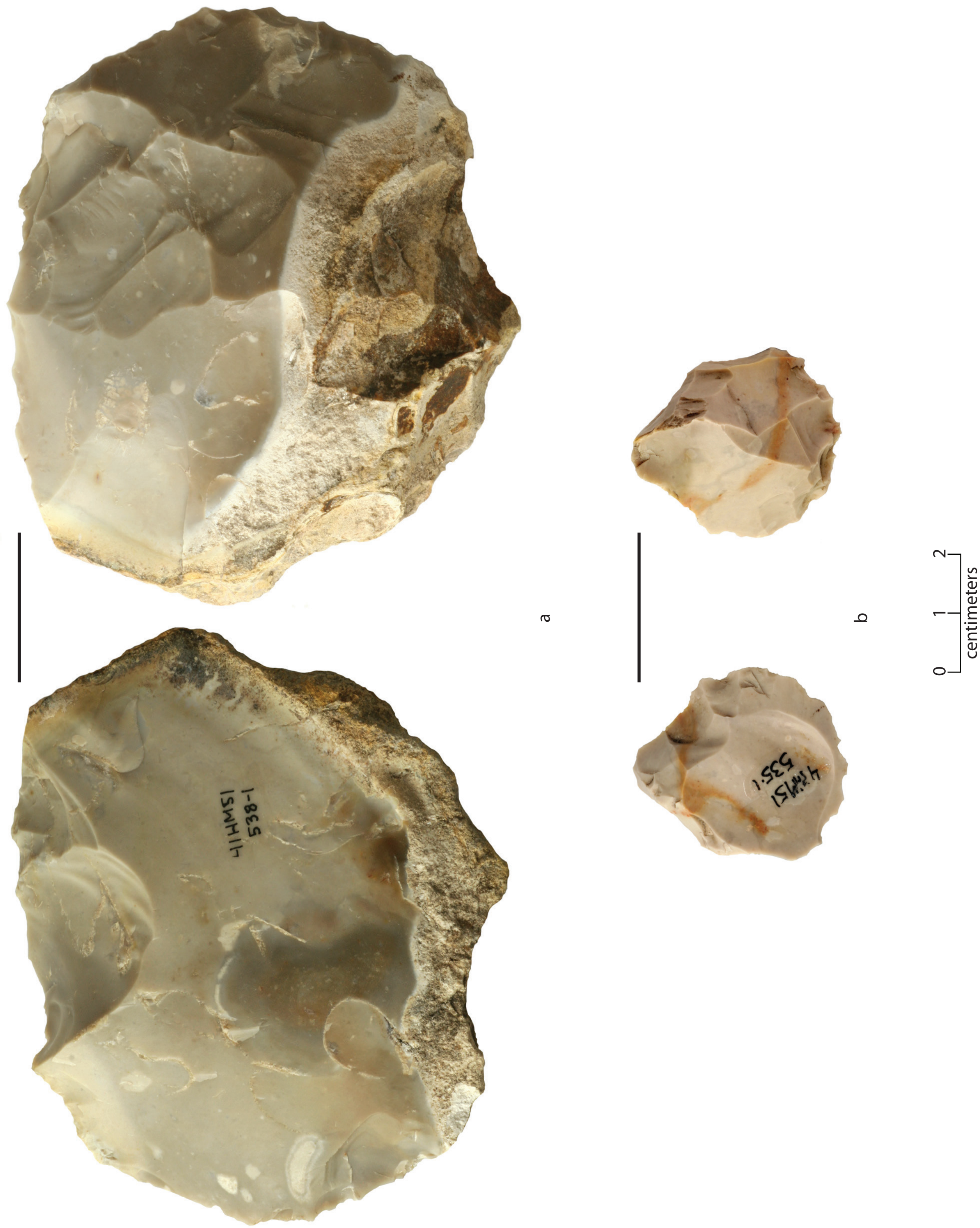


Figure 5.20. Macroflake (a) and microflake (b) cores reflecting flake production.

and discoidal (bifacial) cores were used to produce specific types of flakes. Blade cores were used to make elongated flakes with lengths typically greater than their widths, whereas discoidal cores were used to produce larger, thinner flakes with an expanding shape. Although little evidence of elaborate platform preparation is present with either blade cores or discoidal cores, flake removal for both core types was patterned to produce the associated flake types. Both types of flakes were employed to produce a variety of edge-modified tools present in the assemblage. Core types, debitage, and informal and formal tools argue for at least two, and possibly three, different flake production methods in use at the site: bifacial or discoidal cores used to produce flakes for artifacts like projectile points and small bifaces; blade cores to produce specialized laminar flakes; and general percussion cores to produce thicker flakes of variable shape for a variety of expedient or minimally modified tools and unifaces.

Flake cores display greater striking platform variability than blade cores. There are 2 with cortex platforms, 4 with single-facet platforms, 2 with mixed platform types, and 13 with multifaceted striking platforms. The platform type on 1 flake core fragment could not be determined. Blade cores include 2 with single-facet platforms and 1 each with natural cortex and multifaceted platforms. The small sample precludes detailed interpretations of platform preparation, but it is apparent that both blade cores and discoidal cores required some degree of faceting and preparation prior to and during flake production. Platform abrasion or grinding does not appear to have been a significant part of that preparation, but it may have been intermittently employed during the flaking process.

The maximum length and width of all whole cores and tested materials provides a general idea of the raw materials that were available (Table 5.4). Complete cores range in maximum dimension from about 30 mm to slightly over 100 mm, with the majority clustering loosely between 40 and 70 mm.

Debitage

The debitage consists of 6,589 pieces of debris (inclusive of whole flakes, blades, flake and blade fragments, and shatter) and weighs 6,855 g. Of the total, 6,581 pieces are chert, 3 are quartzite, and 5 are obsidian. The chert portion weighs 6,833 g, the quartzite is only 22 g, and the obsidian is just 0.4 g. The 3 pieces of quartzite appear to be impact spalls from hammerstones and match lithologies of fragmentary hammerstones in the artifact assemblage. The small obsidian specimens consist of 4 retouch or pressure flakes and 1 flake fragment. All appear to have been removed from a bifacial tool of some type. The flake fragment is from the Valles Rhyolite source, and the small retouch flakes are from the Cerro Toledo Rhyolite source. Three of the latter are clustered within 3 m of each other in the excavation block and could represent a single reduction event. The fourth was found about 3 m away from that cluster. None of these flakes could be refit, however.

Table 5.5 shows the totals of flakes in each size grade. The debitage is dominated by flakes in smaller size grades, particularly Grades 3–5, which have 97 percent by count and 63 percent by weight of all debitage. The predominance of debris one-half inch and smaller indicates that the assemblage does not contain

Table 5.4. Dimensions and weights of cores and core fragments

Lot No.	Artifact No.	Core Type	Length mm)	Width (mm)	Thickness (mm)	Weight (g)
107	1	bifacial or discoidal	86.87	79.73	28.5	193.64
341	4	bifacial or discoidal	31.2	29.84	15.54	16.13
499	1	bifacial or discoidal	60.24	40.64	32.24	80.13
334	2	bifacial or discoidal	64.58	63.09	33	145.65
473	1	bifacial or discoidal	73.33	57.25	15.52	76.85
156	1	bifacial or discoidal	58.21	51	18.89	60.51
608	2	bifacial or discoidal	38.79	39.83	8.28	15.3
614	1	bifacial or discoidal	47.01	43.13	10.92	25.1
111	1	bifacial or discoidal	46.11	47.79	29.1	44.73
698	1	blade	51.94	44.83	30.92	89.84
506	2	cobble/pebble	54.85	64.76	56.11	231.65
706	1	core fragment	75.54	51.41	19.83	59.19
215	1	core fragment	68.91	60.55	14.66	57.79
370	5	core fragment	43.89	43.61	12.27	28.41
278	1	core fragment	46.99	45.21	27.93	59.29
674	1	core fragment	45.2	35.99	21.19	29.16
175	1	core fragment	49.41	25.82	15.22	18.32
43	1	core fragment	53.94	36.12	19.98	41.88
378	2	core fragment	43.51	26.51	21.42	22.63
538	1	large flake core (macroflake as core blank)	100.72	84.88	25.1	200.3
535	1	microblade/microflake	35.4	31.68	17.9	14.38
375	4	noncortical core	61.83	46.51	30.72	93.43
217	1	partial cobble/pebble	41.17	40.75	20.01	39.73
651	1	partial cobble/pebble	47.76	64.84	18.29	64.54
435	1	tested cobble/pebble	46.45	45.53	28.85	72.91
711	2	tested cobble/pebble	53.59	52.38	32.99	115.34

much material produced during primary reduction of nodules and cobbles. It may also reflect an emphasis on the late stages of formal tool manufacture, finishing and repair/maintenance tasks, and flake tool retouch and resharpening. However, this pattern also undoubtedly reflects the fact that flakes and blades are missing from the larger size grades because they were selected for the manufacture of flake tools and unifaces. The Grade 5 sample also is biased in that it includes some microdebitage from feature contexts that were treated as flotation samples.

Table 5.5. Flake size grade counts and weights for the chert debitage

Size Grade (screen mesh size)	Number	Percent (#)	Weight (g)	Percent (wt)	Pieces with cortex	Percent with cortex
1 (1.0 inch)	42	0.6	1,062.4	15.5	34	81.0
2 (0.75 inch)	165	2.5	1,450.5	21.2	71	43.0
3 (0.5 inch)	794	12.1	2,259.3	33.0	228	28.7
4 (0.25 inch)	3,350	50.8	1,820.2	26.6	440	13.1
5 (<0.25 inch)	2,238	34.0	263.0	3.8	49	2.2
Totals	6,589		6,855.4		822	

Cortex is present on 822 flakes, or 12 percent of the assemblage (see Table 5.5). Not surprisingly, the percentage of flakes with cortex decreases as flakes get smaller, reflecting the fact that, on average, small flakes were detached later in the reduction sequence than larger ones. The small number of corticate flakes in the smaller size grades could have been produced by retouching of larger cortex-bearing flakes into flake tools including convex end and other unifaces as well as simple core platform preparation.

Adding size information for the flake tools and unifaces in the assemblage to the debitage size grade data provides a broader view of the technological character of the core reduction and tool production activities at the site, since the former were culled from the debitage in the tool manufacture process. It also provides a better understanding of the desired tool blank characteristics and tool design. Maximum dimensions for the 51 complete unifaces (side and convex end scrapers) and flake tools vary between 15.9 and 87.8 mm (mean = 49.1, median = 48.9, standard deviation = 13.9), with 40 being between 40 and 65 mm. Clearly, almost all of these exceed the largest debitage size grade (Grade 1). This indicates that generalized core reduction for flake production was conducted on the site and provides additional evidence of a technological link between the various cores in the assemblage and the flake tools. Thirty-seven percent of the 51 complete unifaces and flake tools bear remnant dorsal cortex, and this may help explain the corticate flakes in Size Grades 3 and 4, since they could have been produced during retouch of cortex-bearing tool blanks.

Flake and Blade Tools

Flake and blade tools come in two forms, unmodified and modified. Unmodified blanks (flake or blade) were used as implements without prior edge modification. Modified flake tools have varying types and amounts of retouch along one or more edges but cannot be classified into standardized tool forms such as convex end unifaces. Herein, modification refers to deliberate retouch and not alteration of edges by tool use. A total of 95 tools fall into this category. All were manufactured from chert flake and blade blanks. Unifaces are discussed separately below.

The largest subcategory (n = 90) is indeterminate flake tools (Figure 5.21). Indeterminate refers to the unknown functions of these implements. Functional assessments are not assumed based on form, type of retouch, or other characteristics. Of these 90 implements, 27 (30 percent) were manufactured on blades or blade-like flakes, and 63 (70 percent) were manufactured on flakes. Thirty-four exhibit no retouch, 29 have marginal edge nibbling, 18 have marginal pressure flaking, 6 exhibit marginal percussion retouch, and 3 have random or indeterminate retouch. Fragment and fracture patterns indicate that breakage was typically into two or three fragments: 31 are complete, 17 are proximal or proximal-medial, 10 are medial, 16 are distal or distal-medial, and 16 are indeterminate fragments. Cause of discard could not be determined on 45 tools, the majority of these being complete. Fractures that can be inferred to reflect use or manufacture breakage are present on 24 tools. These are perverse and snap/end shock fractures. One tool was discarded due to excessive heat damage. Twenty tools (22 percent) exhibit fractures that are considered to reflect deliberate breakage; these include

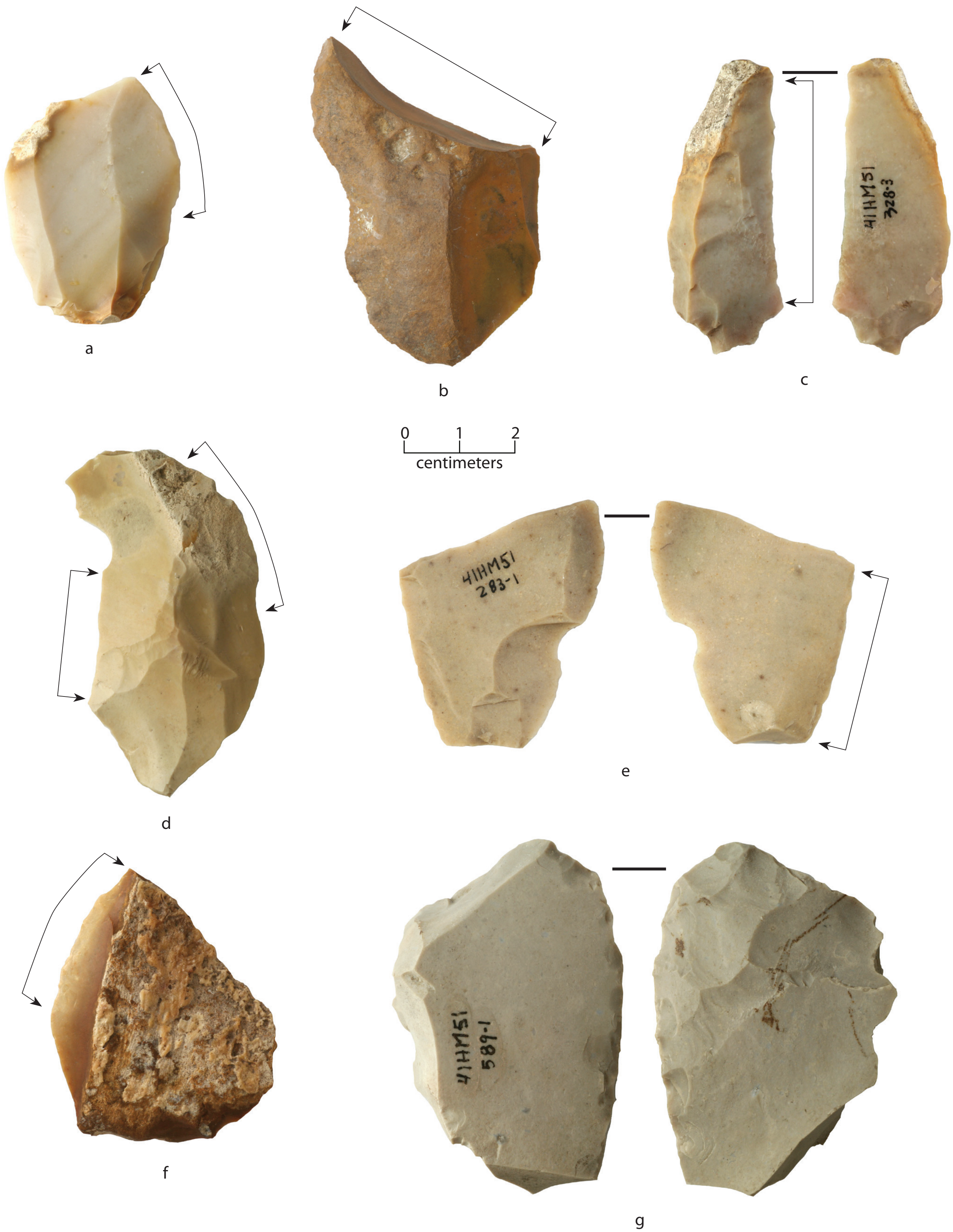


Figure 5.21. Modified and unmodified flake tools. (a–d) Unmodified flake and blade tools; (e) blade with marginal edge nibbling; (f) flake with marginal pressure flaking; (g) flake with bifacial marginal percussion flaking. Arrows and bar denote location of use wear.

radial, radial/snap, and snap breaks caused by placing the tool on an anvil and using percussion to fracture the tool into smaller segments. In every case, those with edge modification were retouched prior to breakage, indicating that complete tools were being secondarily modified.

The size range of flakes selected for these tools is based on 31 complete specimens. Length varies between 20.0 and 62.9 mm and width from 19.1 to 56.8 mm. Most are 20–40 mm wide and 40–60 mm long. This could indicate that the cores from which the flakes were removed were of rather uniform size or that flakes selected for these types of tools were chosen based on certain size parameters.

Tool edge angles could be recorded on 73 of the 90 flake tools with a total of 97 distinct edges, since some tools have multiple edges. For retouched edges, this represents the retouch angle, whereas on use-modified tool edges, this represents the angle of the flake edge without retouch. Edge angle values broadly correlate with the presence or absence of retouch and the type of retouch. Edges with no retouch (n = 46) have angles between 22 and 59° with a mean of 37°. Edges with pressure retouch (n = 14) have angles between 30 and 56° with a mean of 44°. Edges with marginal edge nibbling (n = 30) exhibit angles between 24 and 76° with a mean of 52°, while edges with marginal percussion retouch (n = 6) have angles between 40 and 75° with a mean of 56°. There is considerable overlap, but there appears to be a tendency for steadily increasing edge angles with retouch type. Edges with no retouch tend to have more-acute angles than edges with any type of retouch modification. Of these 73 tools, 51 have 1 modified edge, 21 tools have 2 edges, and 1 tool has 4 edges. Tools with 2 or more modified edges may have been used for multiple functions.

A second group of flake and blade tools consists of three flakes with burin spall facets and two fragmentary burin spalls (Figure 5.22). The former could be considered burin spall cores as well. One specimen is an angular fragment with burin spall facet scars along one edge. A second is a percussion flake fragment with burin spall facets on one face/end. Dorsal streamworn cortex is present. The third is a flake fragment with some streamworn cortex on the dorsal face. One end has been truncated with marginal percussion to serve as the striking platform for burin spall removal, however, the platform collapsed after spall removal. The first spall is a distal fragment of an edge-modified burin spall flake. The second is a long burin spall removed along an edge of a modified flake tool. The use of the burin technique also appears in other tool categories from the Jayroe site. Each of the burin spalls exhibits marginal edge nibbling, but it is uncertain if the retouch is from use or to regularize the edge prior to flake removal.

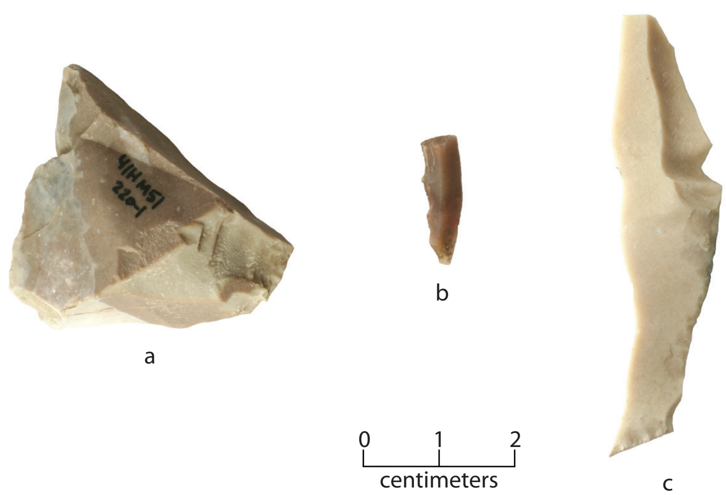


Figure 5.22. Burin technology on flake tools. (a) Flake fragment with burin spall facet; (b) distal fragment of burin spall; (c) burin spall with marginal nibbling on lateral edge.

Convex End Unifaces

There are 17 whole and fragmentary convex end unifaces (Figure 5.23); other analyses often refer to such tools as scrapers, end scrapers, or hide scrapers. All are chert. These are ovate to elongated implements with one end unifacially retouched into a convex shape. Blanks for these tools consisted of both percussion flakes and blades or blade-flakes that were considerably modified by retouch from the original blank. Thirteen are complete, and 4 are broken. The broken specimens consist of 3 distal fragments and 1 distal-medial fragment. The majority (n = 9) appear to have been discarded once they were exhausted. Two exhibit deliberate radial breaks, 1 has a snap/end shock break, and 5 are indeterminate for reason of discard. Retouch techniques are variable: 10 have marginal percussion, 5 exhibit invasive percussion, and 1 each has marginal edge nibbling and pressure flaking. Length is always greater than width. Length varies between 25.1 and 87.8 mm, and width ranges between 15.7 and 55.1 mm. The pattern was for selection of elongated blanks, with widths generally between 20 and 40 mm.

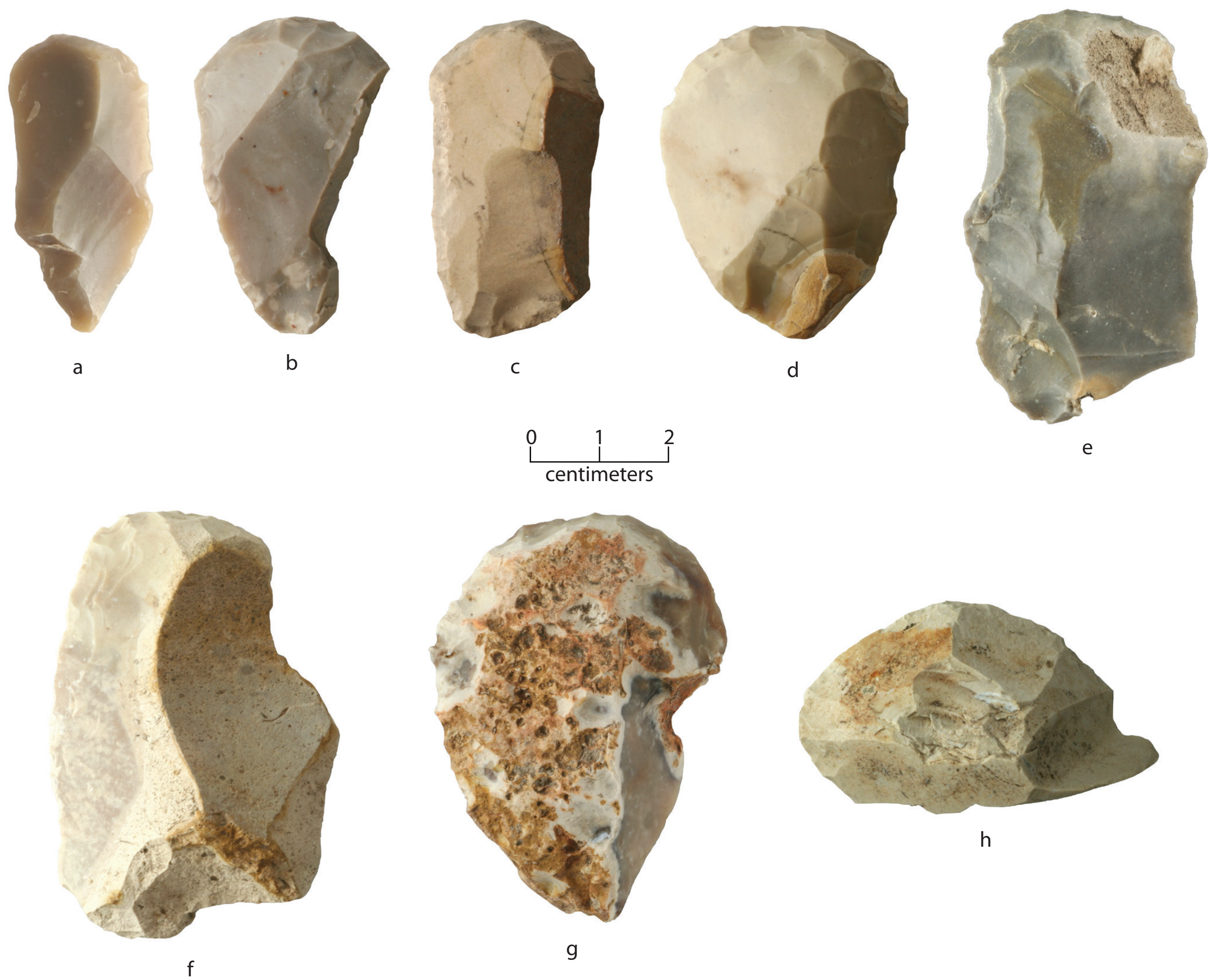


Figure 5.23. Convex end unifaces. (a–g) Complete tools; (h) distal fragment.

Other Unifaces

Twenty-one other artifacts are unifaces or uniface fragments that differ from convex end unifaces (Figure 5.24). All are manufactured of chert. Retouch type and location make this group variable in type and function. They are described as a group because they all exhibit unifacial retouch, even though they represent an array of morphologies and retouch locations. The group consists of 1 end/side scraper, 2 side scrapers, 1 end scraper, 1 spokeshave, 1 beaked tool, 4 indeterminate unifaces, 1 uniface resharpening flake, and 10 uniface fragments with deliberate radial or snap breaks. Nine implements are complete, and 12 are fragmentary. Of the broken ones, 10 appear to have been deliberately fractured as part of raw material conservation strategies described below.

The end/side scraper (see Figure 5.24a) and end scraper both exhibit marginal percussion flaking. The former is a side-struck percussion flake with percussion retouch on the convex end and unifacial edge nibbling or retouch on two other edges. The end scraper is a distal fragment that has a deliberate snap break. One of the side scrapers is manufactured from a chert blade with some streamworn dorsal cortex (see Figure 5.24b), and the second is made on a distally converging percussion flake. Both are complete, and one has part of the dorsal right lateral edge altered by invasive percussion retouch. The second tool has marginal edge nibbling retouch along the right dorsal lateral edge.

The spokeshave (see Figure 5.24c) was manufactured on a small flake with one edge having a localized concavity created by marginal nibbling retouch. The distal end is alternately modified by the same type of retouch but exhibits a broad point. The proximal end is bifacially retouched. The beaked tool is a steeply retouched uniface with marginal percussion on the proximal end to create a small isolated projection (see Figure 5.24d).

Three of the indeterminate unifaces have marginal percussion retouch, and the fourth has steep abrupt percussion retouch. One is a distal fragment of a large flake with a hinge termination. Both left and right dorsal lateral edges are retouched by marginal percussion. The right edge was retouched to thin the piece, and the left edge may have cutting wear. A second tool was manufactured on an elongated percussion flake with a broad convex distal end retouched by marginal percussion onto the dorsal surface. The third, a percussion flake with streamworn cortex, exhibits marginal flaking along the distal end and the right dorsal lateral edge. The final tool may be the distal end of a convex end uniface. Two areas of localized impact damage similar to that produced on wedges is present along one lateral edge and along a transverse break.

The uniface resharpening flake was removed from the distal end of a convex uniface and follows the general contour of the end of the original uniface (see Figure 5.24e). Unlike other resharpening flakes removed by percussion, this specimen appears to have been removed using a burin technique to reshape the distal end of the uniface.

Uniface fragments with radial and snap breaks are represented by two distal, three proximal or proximal-medial, one medial, and four indeterminate fragments.

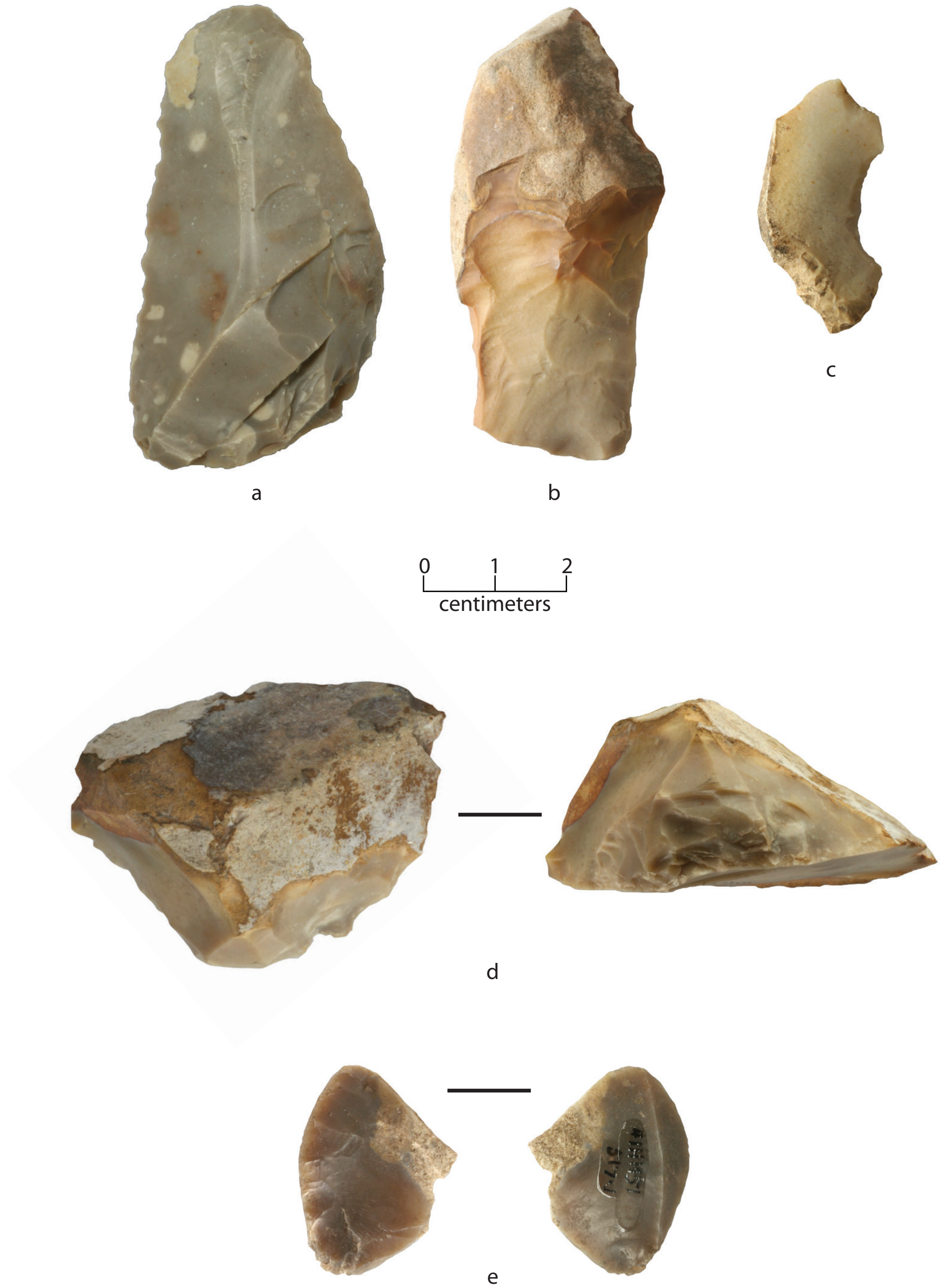


Figure 5.24. Other unifaces. (a) End/side scraper; (b) side scraper; (c) spokeshave; (d) beaked uniface; (e) uniface resharpening flake.

Some appear to be portions of convex end unifaces that have been broken to extend the utility of the raw material. Retouch techniques include seven with marginal percussion and one each with invasive percussion, marginal pressure flaking, and marginal edge nibbling.

Drills, Perforators, and Gravers

Fifteen piercing tools, i.e., drills, perforators, and gravers, are present. All are manufactured from chert flakes or blades. There are 9 unifacial or bifacial drills (Figure 5.25a–c), 4 perforators (Figure 5.25d–f), and 2 flake tool gravers (Figure 5.25g). Five of the drills are proximal or proximal-medial fragments, and 4 are distal fragments. Two perforators are complete, and 2 are proximal-medial fragments. The broken drills and perforators all exhibit snap or bending fractures resulting from use and torsion breakage. Drill and perforator tips were manufactured by pressure flaking, whereas the proximal ends of these tools were trimmed by marginal pressure, marginal percussion, edge nibbling, or a combination of these techniques. Unlike the bifacial drill tip fragments, perforators have alternately retouched edges. The graver tools were manufactured by a combination of marginal edge nibbling and invasive percussion flaking. Obvious wear is present on a number of the distal fragments. Three fragments refit and represent one complete drill. The distal fragment was recovered about 3 m northwest of the base, and the medial portion of the bit was found about 5 m southwest of the base fragment. It is unknown if this distribution reflects intentional discard of broken tool portions in different areas or postdepositional disturbance.

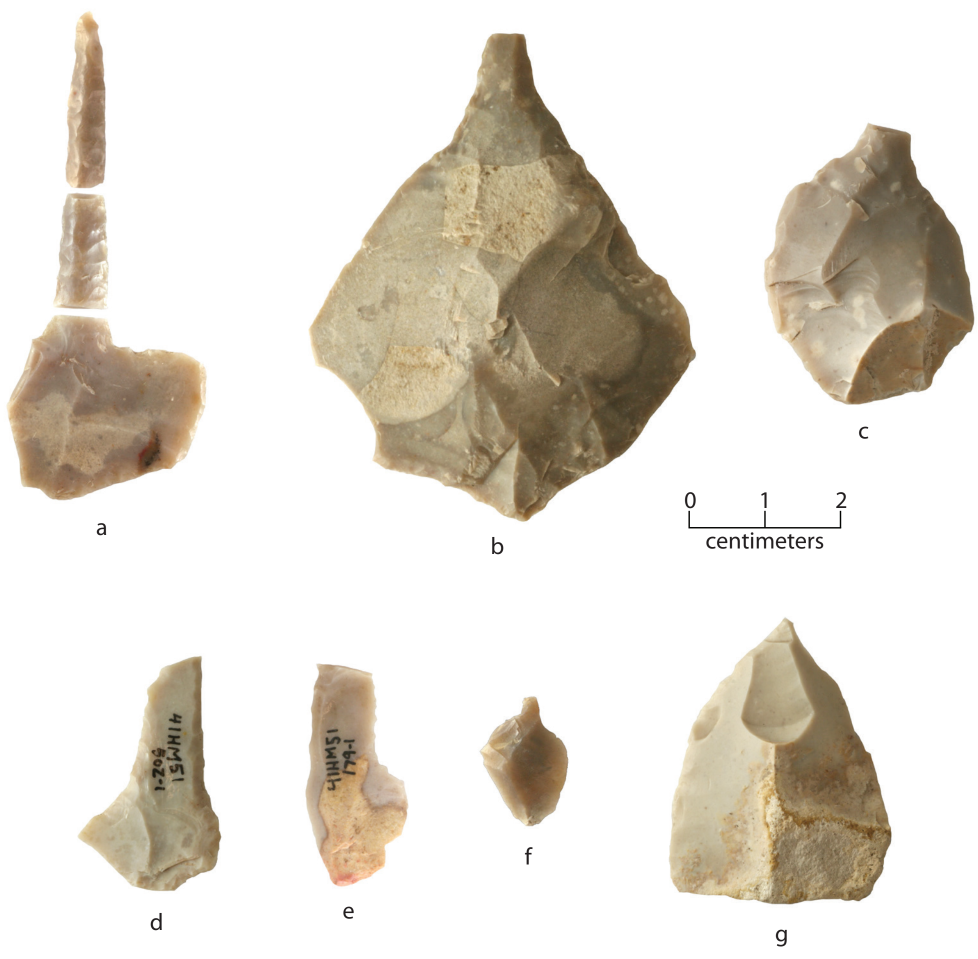


Figure 5.25. Drills, perforators, and graver. (a–c) Pressure-flaked drills; (d–f) pressure-flaked perforators; (g) flake graver.

Chopping Tool

This tool is manufactured from a large pebble of mottled medium and dark gray coarse-grained fossiliferous chert with streamworn exterior cortex. Based on UVF analysis, the raw material is comparable to cherts in the Pennsylvanian Ranger and Winchell limestones 70–75 km north and the northwest of the site. Roughly two-thirds of the circumference is bifacially flaked (Figure 5.26). Heavy crushing damage is present on two opposing portions of the edge, and the distal end is only modestly damaged from use. The opposed edge damage and battering created slight concavities from concentrated use. This type of damage could have been created via bipolar percussion and use as a wedge to break up hard materials such as bone. Crushing and step fracture damage are consistent with this type of use.

Figure 5.26. Chopping tool.

Bifacial and Beveled Knives

Thin bifacial knives and beveled knives are a technological hallmark of Toyah lithic assemblages (Figure 5.27). All 20 knives were manufactured by well-executed and controlled bifacial flaking from well-prepared and maintained bifacial striking platforms; all are of good- to excellent-quality chert. A number of the larger specimens exhibit fully bifacial flaking from opposed edges with the distal ends of flake scars terminating near the biface midline. Characteristic of these types of knives, the flake scars reflect the removal of broad, thin, and expanding flakes from each face. There are 12 beveled knives and 8 other knife fragments that are not beveled. Based on fracture characteristics and material color, some of the chert appears to have been heat treated.

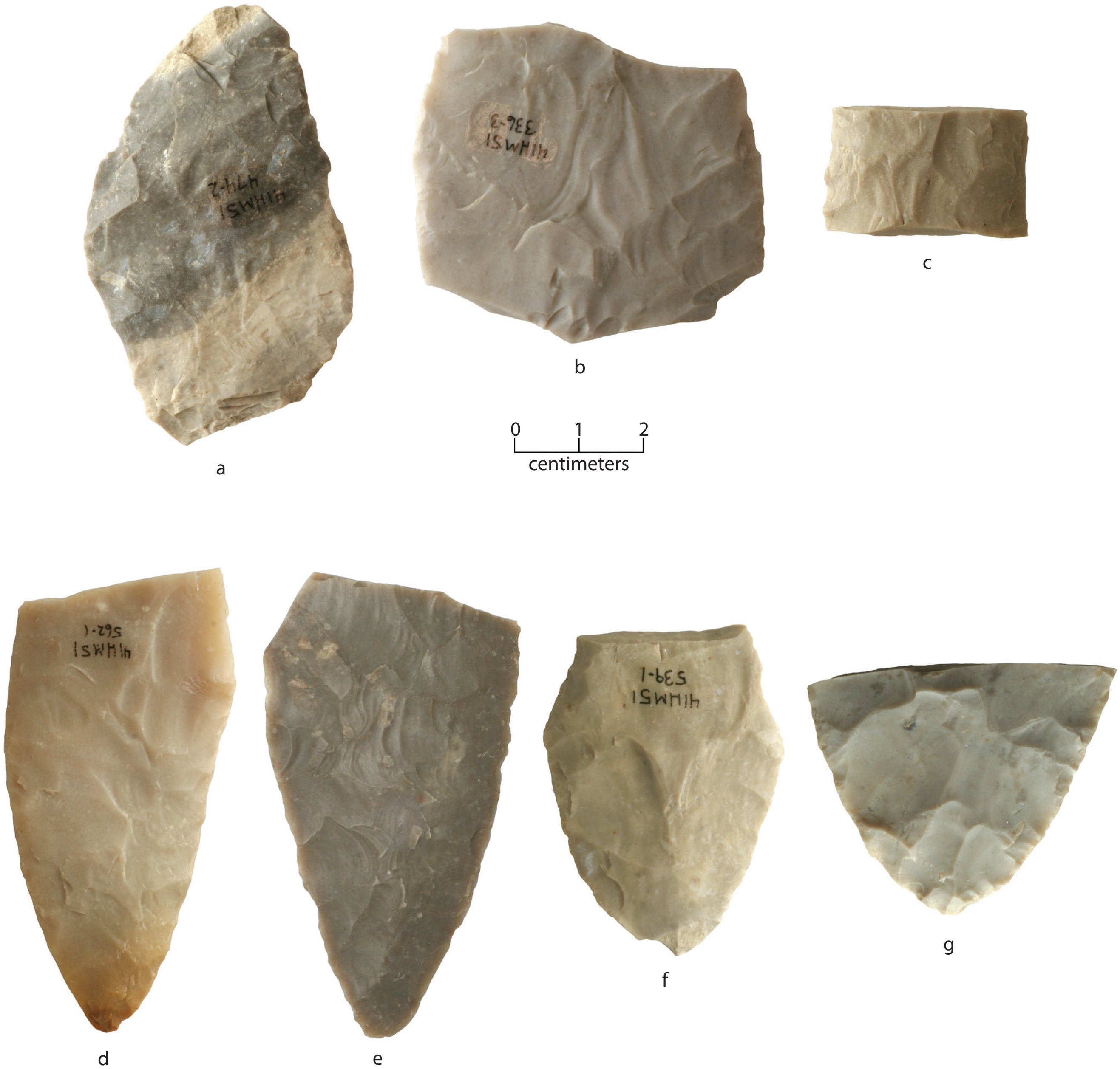


Figure 5.27. Bifacial knives. (a) Heavily resharpened beveled knife; (b–c) medial fragments of beveled knives; (d–g) end fragments of beveled knives.

One beveled knife is relatively complete, 2 are proximal or proximal-medial fragments, 2 are medial fragments, 4 are distal fragments, and 3 are fragments that could not be determined to portion. Unbeveled knives are all fragments: 3 proximal, 2 medial, 2 distal, and 1 indeterminate. Based on technology, flaking characteristics, and raw material similarities, it is possible that beveled and unbeveled knives represent the same artifact type, with beveling present on some due to resharpening and maintenance. They could also represent unbeveled fragments of otherwise beveled knives. Fracture patterns and reasons for discard are similar. The complete beveled knife was discarded because it appears to be worn out. All specimens represent late stage/finished implements based on thinness and presence of edge beveling. Some breakage is related to manufacture or use: 1 overshot and 13 snap/end shock breaks. Other breakage is deliberate and is similar to breaks observed on other tool classes discussed above: 2 snap breaks, 2 radial breaks, and 1 radial/snap break. These breakage patterns indicate that some bifacial knives were broken during use, but other fragments were deliberately snapped to extend the utility of the raw material or to manufacture other tools from the fragments. Whether these implements were broken at the site or the fragments were returned to the site from their use somewhere else is not known. There is little evidence that these tools were manufactured at the site, but they were used, broken, and possibly recycled there.

It is not possible to discuss the size variability among beveled and unbeveled knives due to the degree of breakage. Among fragments, the most meaningful measurements are width and thickness. Width varies from 18.9 to 54.4 mm, and thickness varies between 4.0 and 8.1 mm. Variation in width is due largely to fragment representation and the presence or absence of edge beveling.

Other Bifaces

The category of other bifaces consists of 47 specimens representative of various manufacture, use, and discard stages. This grouping includes all bifaces and fragments that could not be assigned to a specific formal type (e.g., knife, dart point, or arrow point). Six are Stage 1, 11 are Stage 2, 5 are Stage 3, and 2 are Stage 4. Also present are 3 fragments with burin retouch, 3 indeterminate bifaces, 1 fragment with a radial break, and 16 indeterminate fragments.

Four Stage 1 bifaces are complete, and the others are medial and proximal fragments. Five Stage 2 bifaces are complete, 2 are proximal fragments, 2 are proximal-medial fragments, and 2 are indeterminate fragments. One Stage 3 is complete; another has missing lateral edges, 1 is a distal fragment, and 2 are indeterminate fragments. The Stage 4 bifaces are a medial fragment and an indeterminate fragment. Among the fragments of various stages, it is apparent that manufacture failures were the primary reason for discard. Reasons for failure or discard for the entire group are as follows: 4 exhausted, 3 with excessive heating, 16 snap/end shock breaks, 4 platform loss, 2 edge collapse or platform loss, 1 hinge/step damage (thinning failure), 2 perverse fractures, 2 overshot (outrepasse), 1 with an internal material flaw, 2 with radial break fractures, and 10 that are indeterminate as to discard reason. All of the complete bifaces are too small to be part of the bifacial knife and beveled knife manufacture trajectory. Most are small ovate bifaces that could represent preforms of small hafted or unhafted bifacial knives, arrow points, or other similar artifacts. Their smaller size may be an indication why none of them appear to have been recycled or conserved via radial breaks or snap breaks.

Special to this group are three biface fragments that have burin spall facets (Figure 5.28). All three exhibit such facets on two edges and from opposing directions. Each of these fragments is from a biface manufactured from good-quality chert that appears to have been heat treated. Flake scar characteristics that remain on both faces are comparable to those observed on whole and fragmentary examples of the larger bifacial knives and beveled knives. It is probable that these are fragments of similar types of bifaces.

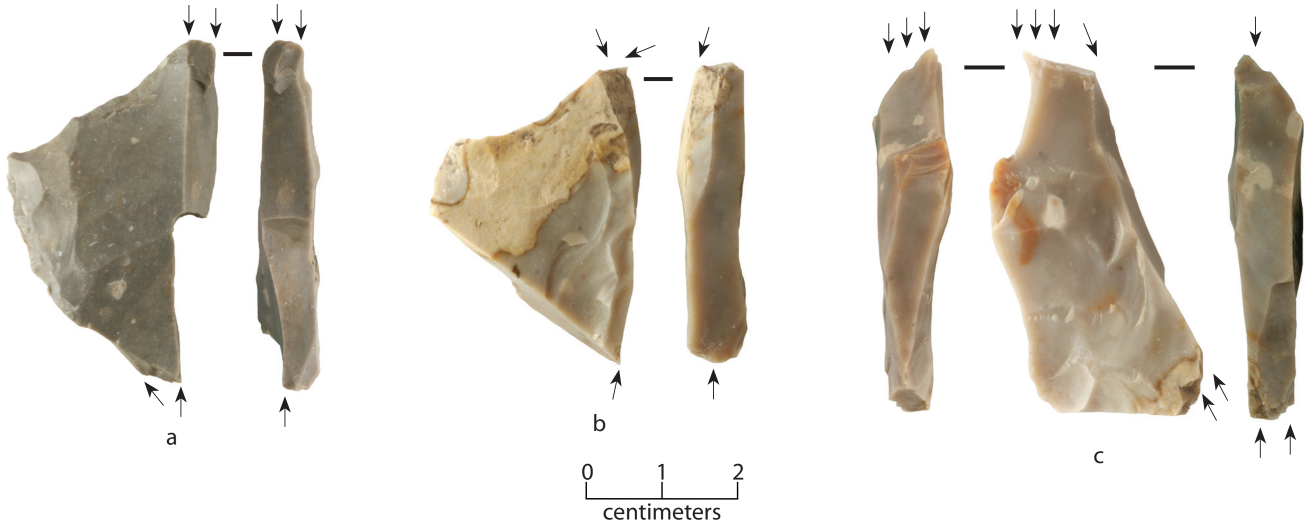


Figure 5.28. Biface fragments repurposed as burins or burin spall cores. (a–b) Burin spall scars from opposing ends; (c) burin spall scars from opposing ends along two sides of the biface fragment. Arrows denote number and direction of burin spall removals.

Dart Points

Only two dart points were recovered: one Ensor and one Darl (Figure 5.29). None of the previously discussed bifaces or biface fragments could be identified as dart point preforms or dart point fragments. Both dart points were manufactured of Edwards chert.

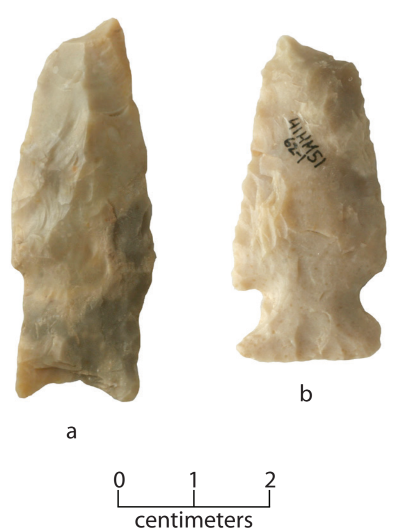


Figure 5.29. Dart points. (a) Darl ; (b) Ensor.

The Darl point was manufactured from fine-grained, heat-treated, mottled, medium-gray and tan-gray chert and exhibits an impact fracture at the tip. Lateral blade edges are slightly convex, shoulders are very slight, and the stem edges are straight and parallel. The basal edge is concave. Stem edges are not smooth. The Ensor point was manufactured from very fine-grained, heat-treated, mottled, light gray and cream chert. The distal end is damaged by an impact fracture. Lateral blade edges are alternately beveled with fine edge serrations. The basal edge is straight with corner notches, and the shoulders have been reworked. The Ensor point was recovered from an Archaic context, but the Darl point was recovered from a Toyah context. This single terminal Archaic point is clearly out of place and may have been scavenged from elsewhere by the later occupants; hence, its presence does not imply concurrent use of the bow-and-arrow and atalatl-and-dart for hunting.

Arrow Points, Preforms, and Fragments

The arrow point grouping consists of 43 whole and fragmentary Perdiz and 12 Perdiz preforms, 1 Cuney, 1 Harrell or Washita, 2 Scallorn, 24 untyped fragments, and 21 non-Perdiz preforms. All represent Edwards cherts, except for 2 untyped obsidian fragments that refit.

Cuney

The Cuney point was manufactured from a very thin, tan-gray Edwards chert flake (Figure 5.30a). The edges are not modified and would have converged distally. Dorsal and ventral flake surfaces are apparent. The stem was created by pressure flaking and is typical of a Cuney base. Lateral stem edges are slightly expanding and parallel, and the basal edge is distinctly concave. The distal end has an impact fracture, and one shoulder is damaged. The tip may have been pressure flaked but is missing.

Figure 5.30. Arrow points. (a) Cuney; (b) Harrell or Washita; (c–r) Perdiz; (s–t) Scallorn; (u) untyped obsidian point.

Suhm et al. (1954:498) associates them with the end of the Late Caddo period and Historic period. The regional distribution includes central east Texas toward the Red River and also into central Texas, being occasional in south Texas. Cuney points have been reported along the lower Colorado River drainage from sites containing Toyah lithic assemblages and bone-tempered/sandy paste and sandy paste ceramics (Arnn 2012a:52, 2012b:211; Hudgins 1986; Kalter et al. 2005). The Cuney type has also been recovered in Texas coastal settings, including the hold of La Salle's ship *La Belle* (Bruseth and Turner 2005:111–112). Elsewhere, they have been recovered in association with Perdiz and Guerrero arrow points, gunflints, and bone-tempered native ceramics on Mission period sites in south Texas (Thoms and Ahr 1995:45, 55; Walter 2007:112). On the shores of Linn Lake in Victoria County, Guerrero, Perdiz, and Cuney arrow points have been recovered along with end scrapers and Rockport ceramics (http://www.texasbeyondhistory.net/st-plains/images/he9.html, accessed January 13, 2014).

Harrell or Washita

One of the fragmentary finished arrow points is morphologically reminiscent of a Harrell or Washita point based on narrow short side notches and the stem breakage pattern (Figure 5.30b). This artifact is a proximal-medial fragment missing the distal end and portions of the base. The blade edges are concave and straight with very finely controlled edge serrations. These types are largely coeval with Perdiz points, and the general geographic distribution of this style includes the Panhandle, west Texas, and much of north Texas (Turner and Hester 1999:217, 236). The raw material is a light gray to off-white fine-grained material that fluoresces as Edwards chert.

Perdiz

There are 43 complete and fragmentary Perdiz points (Figure 5.30c–r) and 12 complete and fragmentary preforms representing stages of the Perdiz point manufacturing sequence. Forty of the finished points exhibit invasive pressure flaking, and the other 3 have marginal pressure flaking. Thirty-four are considered finished in terms of manufacture, 7 are rejuvenated or repaired, and 2 are indeterminate although probably finished. Only 6 are complete, 12 are distal or distal-medial portions, 4 are medial fragments, 9 are proximal-medial fragments, 1 is a stem, 1 is a stem/barb portion, 8 have one barb missing, 1 is a barb/shoulder portion, and 1 has at least one lateral edge missing.

The pattern of breakage and portion representation is distinctly different from that expected solely from breakage during manufacture. It is characteristic of breakage resulting from both use (impact) and manufacture. Three are exhausted, 5 are indeterminate as to failure or discard, 17 have snap/end shock breaks (manufacture or use), and 18 exhibit impact breakage. Those specimens with evidence of distal impact fractures also exhibit other compound fractures, either broken stems, barb(s), or stems and barb(s). Fracture types characteristic of manufacture (primarily), such as perverse, material flaws, edge collapse, and failures to thin, are not represented. The pattern of breakage is comparable to that described by Johnson (1994:85–86) for the Perdiz point sample from the Buckhollow site (41KM16), which is dominated by broken points with multiple fractures. The inferred cause for this pattern was primarily use in hunting and shooting. An absence of refits between finished points at the Jayroe site and fragments with multiple fractures is tentatively interpreted as being due, in part, to return of fragmentary specimens to the site in retrieved hunting gear for repair and also contained within animal carcass parts.

Of the 6 complete points, 5 are fully bifacially flaked on both surfaces, and 1 has a unifacial blade. Determination of bifacial and unifacial blade preparation for the remaining points is based on proximal-medial, medial, medial-distal, and distal fragments. Of these, 21 exhibit blade portions that are flaked bifacially, and 10 have unifacially retouched blade portions retaining a portion of the dorsal or ventral face; 4 are indeterminate. Considering complete and fragmentary examples, there are roughly 26 bifacial points and 11 unifacial ones, with the remainder indeterminate due to fragment type, size, or other considerations.

Blade edges of many points are very finely serrated, whether bifacial or unifacial. Blade edge serration is present on 24 specimens, while 13 exhibit no serrations on blades or blade remnants. These counts are based on complete points and fragments retaining sufficient blade portions for evaluation. Blade edge shape is variable. Paired straight edges are most common (n = 25) followed by paired recurved edges on 4 points and 5 with paired convex edges. Two specimens have paired concave edges, and 3 have mixed edge shape morphologies. Four are indeterminate because they lack sufficient blade edge remnants for determinations.

All finished point stems and stem fragments are fully bifacial and contracting. Most of those retaining an intact stem base are pointed (present on 31 specimens), while only 1 is very convex. None of the specimens retain any evidence of proximal edge grinding.

There is substantial morphological variation within the sample, a trend that has been observed at other sites with sufficient numbers of this point type. The majority were manufactured from thin, flat, expanding percussion flakes, blades, or flake-blades. Retouch varies from minimal edge nibbling to pressure flaking. The majority represent finished specimens with finely controlled serrations along both blade edges. The grouping includes specimens with very prominent barbed shoulders and contracting stems with both pointed and rounded basal ends. Also present are some points with less well-developed barbs/shoulders and examples that are reworked or repaired. The proportion of finished points that are fragmentary suggests that many were broken during use.

Perdiz points are ubiquitous throughout Texas and have played a significant role in developing chronologies for the Late Prehistoric period and definition of the Toyah area. They are attributed to the later subperiod of the Late Prehistoric, A.D. 1250–1650/1750 (Arnn 2012b:45-46; Johnson 1994:87; Prewitt 1981:84, 1985:215, Figure 5). None of the specimens from 41HM51 can be classed as Bonham or Alba. Shafer (2006:17) notes that recurved, commonly serrated blade edges are characteristic of Bonham-Alba, attributes that can be used to distinguish it from

Perdiz. Although edge serration is common on the Perdiz points from 41HM51, any recurving on blades is due to resharpening and maintenance. Stem characteristics on the Perdiz specimens do not compare with those of either Bonham or Alba.

Of the 12 Perdiz preforms, 3 are complete, 1 is a proximal end, and 8 are proximal-medial fragments. Among broken preforms, 7 have snap/end shock fractures, and 2 have perverse fractures, demonstrating that all were broken during manufacture. Based on manufacturing techniques, it is fairly certain that these preforms were broken during pressure or percussion flaking. Retouch or flaking techniques used in blade shaping include invasive percussion, invasive pressure, marginal percussion, and marginal pressure. Some began as simple ovate bifaces or unifacially flaked blanks trimmed by marginal pressure, marginal edge nibbling, or some combination of these techniques and are comparable to the untyped arrow point preforms discussed below.

There are essentially two different manufacturing trajectories represented among the Perdiz preforms that reflect differences in blank type (Figure 5.31). It is possible the two trajectories could merge at some point along the sequence, but this could not be detected given the small sample size. The preforms are equally divided, with six specimens in each trajectory grouping.

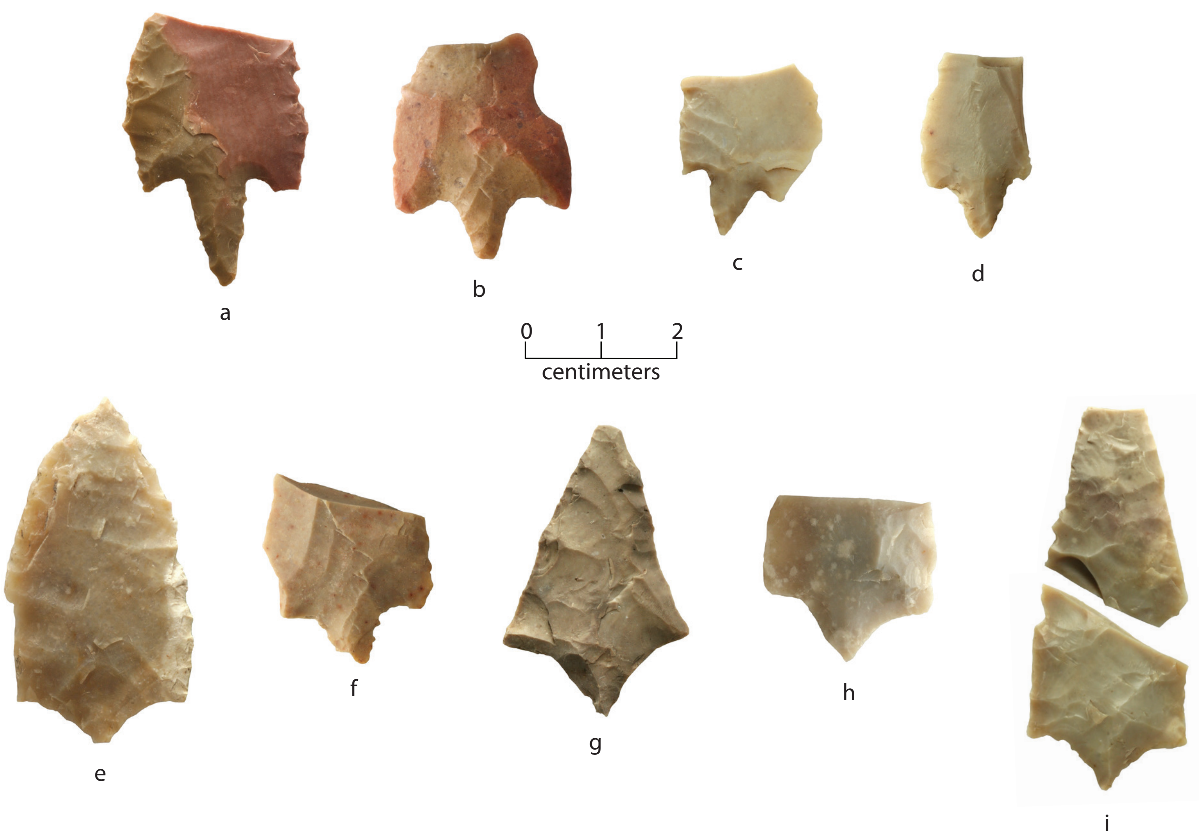


Figure 5.31. Perdiz preforms depicting two manufacture trajectories. (a–d) Trajectory 1, where a contracting stem was completed first on blade-like flakes; (e–i) Trajectory 2, where unifacial and bifacial preforms resembling Cliffton points were created.

The first trajectory began with flakes or flake-blades of suitable size and shape. The stem was the first attribute of the point to be manufactured followed by the barbs and blade edges (see Figure 5.31a–d). The stem was completed by pressure flaking, and blade edges may have had varying amounts of marginal pressure flaking or edge nibbling, although much of the lateral flake edges were still unmodified. The stem appears to have been finished earlier or refined more than the blade. Two examples of this trajectory were manufactured from flakes that were heat treated. A similar mode of Perdiz point manufacture is described by Ricklis (1994:213–214) for some specimens from the Barton site (41HY209).

The second trajectory involved the selection of appropriate flake blanks (see Figure 5.31e–i). Pressure, percussion, or a mix of these retouch techniques was used to create preforms comparable in shape to bifaces traditionally referred to as Cliffton arrow points (Suhm et al. 1954:496–497). Lateral blade edges, shoulders, barbs, and stems appear to have been completed in unison as manufacture proceeded. Stems begun as shallow concavities on the lower lateral edges of the proximal end became deeper and more angular until the contracting stem was completed. Refinement of blade edges appears to have kept pace with stem finishing. All of the preforms of this trajectory have stems that are incipient or rudimentary and unfinished. Proximal and distal fragments representing a complete preform, recovered about 9–10 m apart, were found to refit (see Figure 5.31i). The specimen is broken in a perverse fracture, and there is no indication of secondary use of either fragment as an expedient tool.

Scallorn

Both Scallorn points exhibit triangular blades with straight, serrated, lateral blade edges, deep corner notches, and expanding stems with concave lateral edges and concave basal edges (Figure 5.30s–t). Both were damaged by impact fractures that resulted in the loss of one barb from each specimen and a stem ear from one. The distal end of one has impact damage. One point is fully bifacially pressure flaked on both faces, whereas the other retains a portion of the original ventral flake surface.

Untyped Arrow Point Fragments and Preforms

The remainder of the arrow point and preform group consists of 24 untypeable arrow point fragments, 5 complete preforms, and 16 preform fragments. Two of the untypeable fragments (1 medial and 1 distal) are of obsidian and refit (counted as single specimen); they were found about 7 m apart. The blade was broken in a transverse bending fracture, and the stem is missing. Lateral blade edges are very finely serrated and similar to many of the Perdiz points and blade fragments. Although the point is not typed, the blade and stem areas are similar to Perdiz points from 41HM51. The breakage pattern is also comparable. The blade is fully pressure flaked on the dorsal flake surface, but much of the ventral flake surface is still evident. The remaining 21 arrow point fragments consist of 13 distal or distal-medial portions, 2 proximal or proximal-medial fragments, 3 barb/shoulder fragments, and 3 indeterminate pieces. An unknown number of these are probably associated with manufacture, use, or repair of Perdiz points. Fragment types suggest late-stage manufacture or repair and use as causes for breakage. Fracture types consist of 16 snap/end shock, 4 impact/bending fractures, and 1 perverse fracture. Snap/end shock breaks can be attributed to both manufacture and use. Finely crafted blade serrations are present on 6 distal fragments that are similar or identical to those observed on complete and fragmentary Perdiz points.

All complete preforms are small and ovate and have convex lateral and basal edges (Figure 5.32). Preform fragments consist of 9 distal, 5 proximal or proximal-medial, and 2 indeterminate fragments. The primary cause of discard among arrow point preforms and fragments was related to manufacture breakage. Of the 21 complete and fragmentary preforms, 8 have snap/end shock breaks, 6 exhibit perverse fractures, 1 has a material flaw, 5 are indeterminate, and 1 has a deliberate snap break. This pattern coincides with fragment representation of proximal and distal portions discussed above, and most represent preform breakage in transverse or oblique fractures. This pattern has been previously confirmed as representative of manufacture rather than use breakage of arrow point preforms.

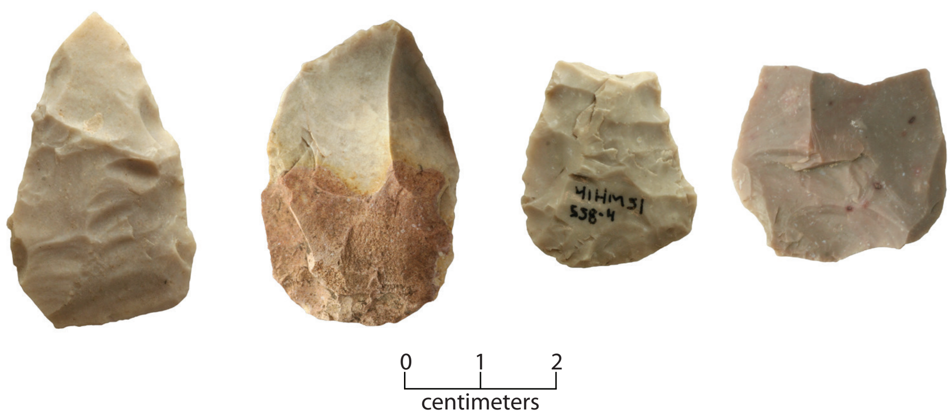


Figure 5.32. Ovate and subtriangular arrow point preforms manufactured from small flakes.

There are slight differences in retouch techniques between the untypeable arrow point preforms and arrow point fragments. Preforms display a greater variety of retouch techniques: 7 with marginal edge nibbling, 9 with marginal pressure, and 5 with invasive pressure retouch. Fragments consist of 16 with invasive pressure retouch, 1 with oblique transverse pressure retouch, 2 with no retouch, and 2 indeterminate. This difference is also present among finished and unfinished Perdiz points, suggesting that retouch techniques like edge nibbling and marginal pressure flaking were often used to establish suitable platforms for pressure flaking.

Hammerstones

These artifacts were identified based on the presence of battered and pitted surfaces. Of the eight hammerstones, three are cherty limestone, and five are orthoquartzite. Both of these raw materials can be procured from the Leon River adjacent to the site as well as in other creek beds and some upland lag deposits. One cherty limestone hammerstone is complete (Figure 5.33a), and two are fragments. The complete specimen has surface potlids and is burned, and one of the fragmentary specimens has thermal fractures suggesting reuse or discard in a hearth. Three of the orthoquartzite hammerstones are of a dense purple material, one is a coarser-grained gray quartzite, and one is white quartzite. Two of the purple ones are fragments of larger cobbles that appear to have fractured in use. The largest hammerstone (of purple quartzite) approaches 800 g in weight. The coarse-grained gray quartzite hammerstone may have a bifacial roughly percussion-flaked edge that is heavily blunted and crushed (Figure 5.33b). The white quartzite example has moderate battering on opposite ends.

Figure 5.33. Hammerstones. (a) Complete cherty limestone specimen; (b) coarse-grained gray quartzite specimen with blunted and crushed edge.

Anvil and Slabs

The single anvil fragment is a squarish waterworn limestone cobble that has been burned and broken. One surface has a natural surface concavity with no wear, and the opposing surface has areas of high relief that have been smoothed and battered through use as an anvil, for example, as a support stone for breaking animal bones or for deliberate breaking of lithic artifacts (Figure 5.34a). The heating and breakage may have occurred subsequent to use.

Figure 5.34. Anvil stone, grinding slab fragments, and polishing stone. (a) Limestone cobble used as an anvil; (b) refitting sandstone slab fragments; (c) sandstone slab fragment with surface striations; (d) polishing stone.

Four slab fragments represent three different implements. They were manufactured of tabular pieces of sandstone, which could have been procured from local drainages and bedrock exposures. Each has at least one flat or slightly concave surface with evidence of grinding and smoothing. Two pieces found about 6 m apart refit to form one palm-sized slab, the edges of which appear to have been roughly percussion flaked to a subrectangular shape (Figure 5.34b). One surface is smooth and relatively flat, and the opposing surface is well smoothed and slightly concave. The reddish hue suggests that the slab was exposed to heat prior to breakage. Another slab fragment has one smoothed surface with superimposed linear striations and grooves, perhaps from sharpening of an implement such as a bone awl (Figure 5.33c). The fourth fragment has a smooth flat surface and one face with adhering conglomerate.

Manos

All three mano fragments are end pieces of elongated or oval specimens. All are sandstone, and two appear to have been burned after breakage indicating that they may have been reused as hearth components. Each fragment has battering in broken areas indicating that the pieces continued to function as hammerstones after breakage. One fragment has a wedge-shaped cross section, and two have oval cross sections.

Polishing Stone

A purple quartzite oval flat pebble may be a polishing tool (Figure 5.34d). The broad surfaces of the pebble have matte smoothed areas suggestive of use for polishing. Alternatively, this could represent prehension wear, or a combination of these. A portion of the pebble edge has very light battering and pecking indicating it also may have been used as a hammerstone.

Indeterminate Ground Stone Fragments

These four artifacts are three small fragments of the same sandstone item (perhaps a mano) and one corner fragment of a limestone implement. All are too small to identify functionally with any certainty.

Potential Pigment Stones

Thirty-eight pieces of material are potential pigment sources. Most (n = 37, 67.1 g) are limonite, ocher, and hematite, while 1 is a blue pigment (mineral unknown, but maybe azurite, malachite, or similar cuprous mineral). Limonite, hematite, and ocher occur naturally within the bedrock geology surrounding the site, frequently as nodules and masses. Various sources of azurite and malachite are known in Llano County (Comstock 1898). Only 3 fragments of limonite, hematite, or ocher retain clear evidence of use, consisting of smoothed or striated facets. The other 35 are fragments of weathered pieces typically less than 1–2 cm in maximum dimension. Specimen weights range from 0.1 to 9.8 g.

Evidence of Deliberate Tool and Flake Breakage

During the analysis, repetitive patterns of fracture types and causes of breakage were observed among certain tool types. The patterns observed and discussed above for bifacial knives and arrow points indicate that many were broken during use and the later stages of manufacture. Other fracture types/causes were observed on expedient tools, bifacial knives, and convex unifaces that appear to relate to raw material conservation efforts. The principal fractures are radial breaks and snap breaks. These types of fractures have been identified in a diverse array of archeological time periods and contexts, including the 95,000-year-old site of Liang Bua in Flores, Indonesia (Moore et al. 2009), pre-Clovis and Paleoindian contexts in North America (Bonnichsen 1968; Deller and Ellis 2001; Frison and Bradley 1980; Goodyear 2006; Jennings 2011), Early to Late Archaic sites in Central Texas (Dockall et al. 2006; Dockall and Pevney 2007:195-197), and Late Prehistoric contexts in east Texas (Shafer 1973). Each type of fracture has distinct technological attributes that can be used to distinguish it from fractures related to tool manufacture or use or tool breakage during trampling. These also have been replicated experimentally (see Jennings 2011). All artifacts with radial, snap, and combination radial/snap breaks from 41HM51 were identified based on experimentally created artifacts at the Prewitt and Associates laboratory.

Jennings (2011) discusses the fracture mechanics of radial and bend or snap breaks, and they are not reiterated here. The physical attributes for recognizing these artifacts in the archeological record and the potential behavioral significance for the Jayroe site are discussed, however.

The general technique for breaking flake tools and bifacial artifacts in this manner is a variation on bipolar percussion, schematically illustrated in Figure 5.35. Rather than striking the target piece along its long axis, it is placed flat on some type of rigid support (e.g., the anvil described above) and struck. The morphology and curvature of the flake or biface tend to influence fracture development. Typical features of these breaks include multiple impact cones or ring cracks on the upper surface, radiating transverse breaks, and pronounced bulbs of percussion on the face of the transverse break (Figure 5.36; Dockall and Pevney 2007:195). Occasional impact spalls break off the top or bottom surfaces. Radial and snap breaks appear to have been created by the same technique. Flat and broad pieces, like expanding flakes and thin flat bifaces that have more surface area and width, appear to produce more radial fractures than narrow or thicker pieces. The location of the point of impact and Hertzian cone defines the upper surface that was struck with the hammerstone.

Thirty-nine artifacts from 41HM51 exhibit radial, snap, or combination radial/snap breaks. Although representing only 12 percent of all chipped stone tools, these fractures are present on 20 percent of generalized flake tools and 25 percent of beveled and bifacial knife fragments, suggesting deliberate selection of artifacts from these categories. Of these artifacts, 21 have radial breaks, 16 have snap breaks, and 2 have radial/snap breaks. The presence of these fracture types primarily among specific artifact categories argues against breakage being

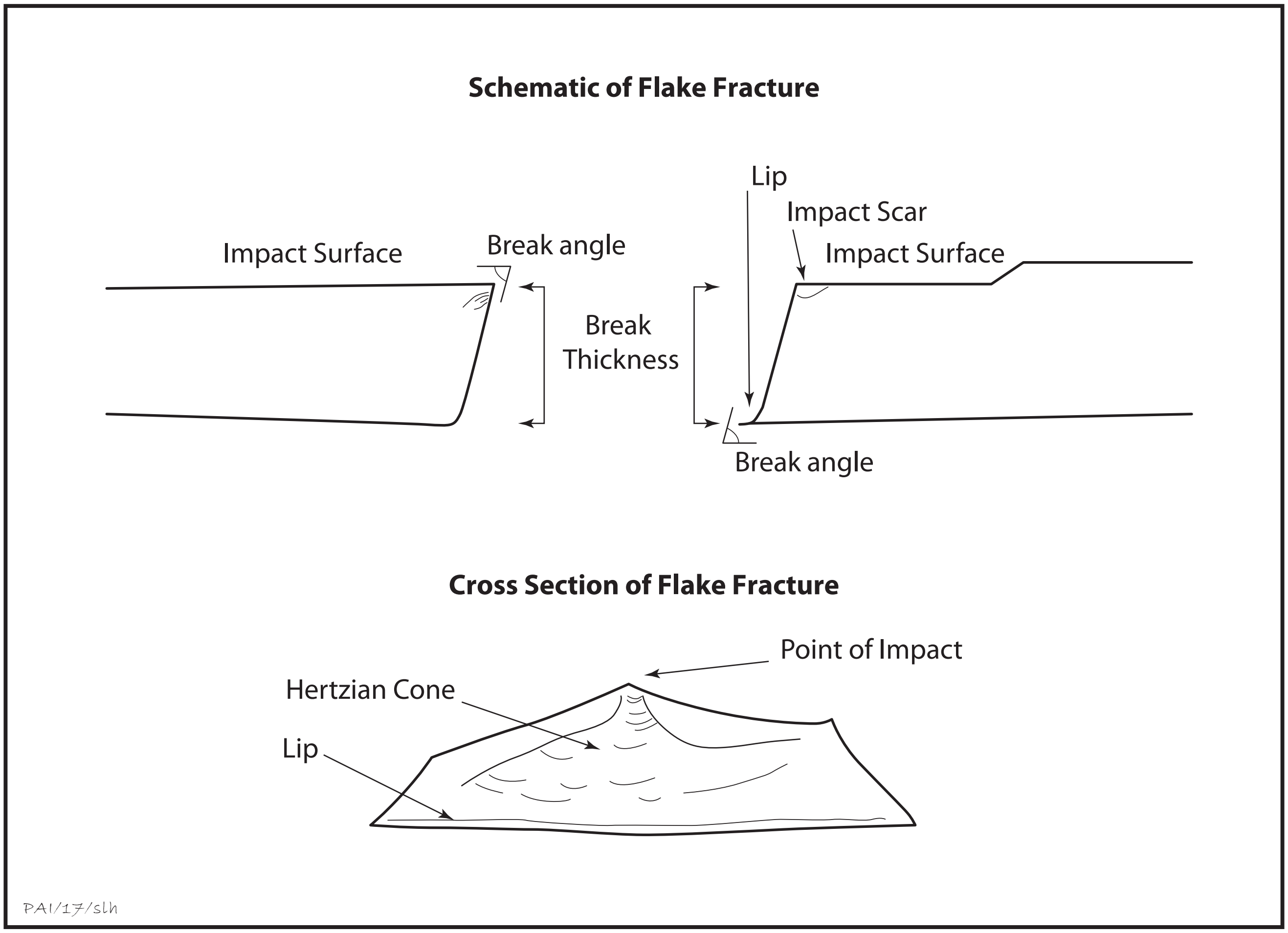


Figure 5.35. Schematic depiction of flake or biface deliberately fractured into two pieces by bipolar percussion (adapted from Jennings 2011, Figure 1). Upper illustration shows profile along a truncation fracture. Lower illustration depicts front view of transversely broken flake with Hertzian cone and point of impact.

due to trampling, postdepositional compaction, or other taphonomic factors (although it cannot be stated with certainty that none of the breakage was due to these factors).

Jennings (2011) notes that biface manufacture and trampling can create fractures that are comparable to radial and snap breaks, but he also notes a difference in the break angle. Radial break angles produced during biface reduction average 77°, while those produced by deliberate snapping are between 83 and 90°. The average fracture angle of 17 of the 21 radial breaks at 41HM51 is 83° with a range from 68 to 90°. Some of these are at the lower end of Jennings's range of fracture angles for deliberate radial breaks, but the common presence of features such as points of impact and partial and complete Hertzian cones, along with concentration of these breaks in two main tool types, supports interpreting the artifacts from the Jayroe site as deliberately broken. Fracture angles on 13 tools with snap breaks range from 60 to 89° and average 80°. The same arguments apply for identifying these snap breaks as deliberate.

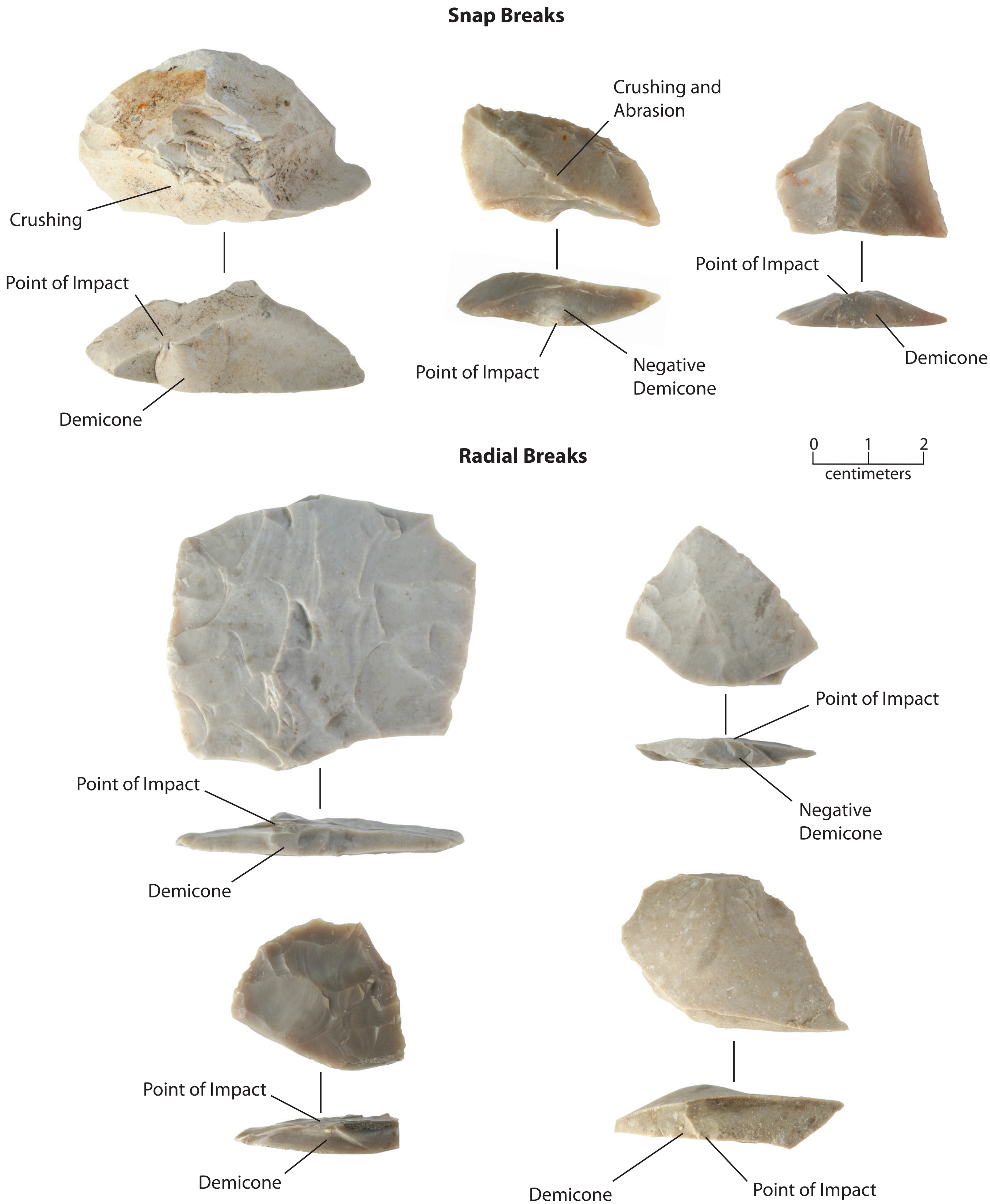


Figure 5.36. Truncated bifaces, flake tools, and fragments from 41HM51 compared to experimental pieces exhibiting a variety of attributes produced by deliberate radial and snap fractures. Specific attributes are labeled.

Behavioral interpretations of these types of broken tools vary. For the Caradoc site in Ontario, Canada, Deller and Ellis (2001) interpret ovate bifaces and unifaces with radial and bend or snap breaks as reflecting ritual or ceremonial destruction. In the pre-Clovis levels at the Topper site, Goodyear (2006:110) interprets bend-break tools and spalls as having been created for burin or chisel use, noting that they were a primary portion of the pre-Clovis lithic technology at the site. At Liang Bua in Indonesia, Moore et al. (2009:511) identify truncation as one of four techniques used to produce flakes and tools, with others being freehand percussion, burination, and bipolar percussion. Here, truncation is described as placement of the flake on an anvil and striking the face with a hammer. Identical features as those described by Jennings (2011) are present on truncated pieces in the 41HM51 assemblage. At the George C. Davis site in Cherokee County, Texas, large radially shattered bifaces occur in ritual burial contexts. Shafer (1973:228) notes the presence of percussor marks and percussion cones on the shattered bifaces. Based on context, the bifaces appear to have been fragmentary prior to burial, and the smashing did not indicate ritual breakage; their placement indicates they might have been intended as tool blanks. Most recently, Wiederhold and Pevney (2014) conducted microscopic use wear analyses of radial and snap break tools from pre-Clovis contexts at the Debra L. Friedkin site. Wear traces and comparisons with similarly produced and used experimental tools led the authors to conclude that these tools were used to groove, incise, and shape hard materials like antler or bone.

To date, there have been no other observations of these types of artifacts in Toyah lithic assemblages or as a consistent part of the Toyah lithic technology, but this may be because analysts have not looked for them. Radially fractured biface fragments were identified in a Late Prehistoric component at 41CM167 (Dockall et al. 2006:98–99). The component included a Perdiz arrow point and an Edgewood dart point. Six of seven biface fragments and two utilized flakes in this component exhibited indications of deliberate breakage through truncation or smashing.

The use of truncation at 41HM51 may represent a technological response to the scarcity of suitable raw materials in the immediate vicinity of the site. A regional chert survey conducted as part of this analysis (see Chapter 6) revealed that the vast majority of streams within the upper Leon River basin do not contain abundant quantities of raw material large enough to produce useable tools. The materials that are present within these drainages are mostly small pebbles of dense quartz and quartzite, with occasional small black and brown chert pebbles and cherty limestone. The absence of any bipolar cores and bipolar debris in the 41HM51 assemblage indicates that bipolar reduction, which would be a logical method to use with such small pebbles, was not a part of the technology.

In most instances where truncation and smashing have been reported as part of the technology, one logical interpretation is that it is related to the provisioning of individuals to perform certain tasks or was employed to create expedient tools from raw material sources on hand. In the case of the Jayroe site, the most readily available sources of raw material undoubtedly would have been exhausted cores, flakes, and other tools.

THE CERAMIC ASSEMBLAGE

A total of 43 ceramic vessel sherds were recovered, representing at least three vessels. These 43 sherds have a total weight of 324.5 g with individual sherds weighing 0.7 to 57.3 g. Sherd size ranges from 10 to 65 mm across, with most sherds between 20 and 40 mm. Thickness ranges from 4.85 to 14.25 mm. The thickest sherd is also the heaviest, as it represents a single flat base fragment that measures 62 mm across. A smaller near-base sherd is 8.85 mm thick. The 9 rim sherds are 5.30–7.05 mm thick. Ten neck or near-rim sherds are 5.86–8.34 mm thick. The remaining 19 body sherds and 3 indeterminate sherds are 4.85–8.73 mm thick.

Paste color is fairly uniform. Thirty-two sherds (74 percent) have a black core, and 15 (35 percent) have both a black core and black exterior. Other core colors are yellowish brown (n = 7), gray (n = 3), and dark grayish brown (n = 1). Exterior colors other than black are gray (n = 12), dark grayish brown (n = 10), and yellowish brown (n = 6).

Temper within the sherd paste is either grog (n = 30, 70 percent) or grog and bone (n = 13, 30 percent). The bone fragments are extremely fine and hard to distinguish even on a fresh break. As such, bone is more common than the numbers above indicate. This is supported by the fact that the sherds from Vessels 1 and 3 described below are not uniform in terms of temper.

All but 1 sherd have a burnished interior surface, but this treatment is present on just the exteriors of just 14 sherds (33 percent). Other exterior surface treatments are smoothing (n = 13), texturing (n = 11), and indeterminate (n = 5). Nine neck and 6 body sherds (35 percent) have burned incrustations probably representing cooking residues on their interior or exterior surfaces.

Twenty-nine sherds (67 percent) are decorated. The decorative modes consist of brushing (n = 8), brushing with incising (n = 2), incising (n = 10), linear appliqué (n = 8), and fingernail punctating (n = 1).

Thirty sherds are assigned to three vessels based on color, decoration, form, temper, and refitted sherds. The remaining 13 sherds may or may not be parts of these vessels, and their possible associations with Vessels 1–3 are discussed where appropriate. If not from Vessels 1–3, then they could represent up to five additional vessels (based on the spatial analysis in Chapter 6).

Vessel 1 is a medium to large jar with an everted rim decorated with wide incised lines encircling the rim from below the lip to the neck inflection (Figure 5.37a–b). The vessel section is composed of 10 sherds from Excavation Units 16, 30, 63 (n = 2), 64, 87, 88, 97 (n = 2), and 128. Most of these units are in the north-central part of the block, and 4 sherds from Excavation Units 30, 63, 88, and 97 refit. The one rim with a rounded lip does not refit to the other neck sherds, but there is little doubt that it is from the same vessel given its similar gray to black paste and decoration. Five sherds have grog temper, and 5 have grog and bone. Seven sherds have burned incrustations, suggesting that it was a cooking vessel.

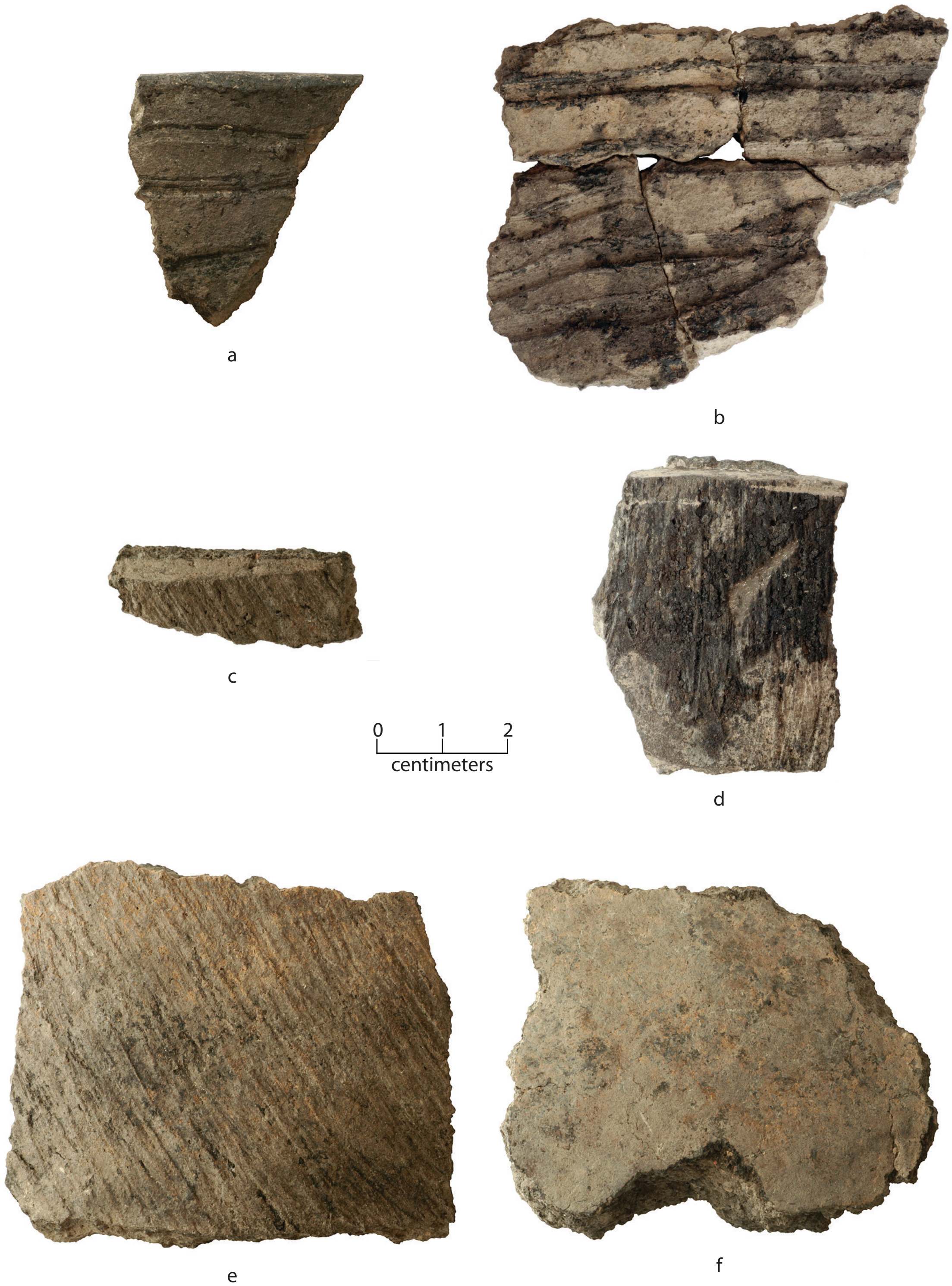


Figure 5.37. Vessel 1 and possibly associated sherds. (a) Vessel 1 incised rim; (b) Vessel 1 incised neck; (c) incised and brushed neck-body sherd; (d) brushed body sherd with burned incrustation; (e) body sherd with diagonal brushing; (f) flat base sherd.

It is uncertain what the body of Vessel 1 looked like, although it may have been brushed. Two brushed body sherds with single horizontal incised lines from Excavation Unit 9 have the same gray to black paste as the rim-neck section of Vessel 1 (Figure 5.37c). The incisions apparently mark the break between a brushed body and the decorated neck of a vessel, but absent larger neck sections, these sherds cannot be linked positively to Vessel 1. Eight other body sherds have the same fine brushing as seen on the two brushed and incised sherds and may be from the same vessel, possibly Vessel 1; they were recovered from Excavation Units 50, 63, 70, 98, 136, and 140 and Test Units 17 and 18 (Figure 5.37d–e). These sherds have a gray to black paste. Three have burned incrustations. In addition, a thick flat base sherd from Test Unit 17 could be associated (Figure 5.37f). A jar with a flat base, brushed body, and incised rim-neck is a common Caddo utility vessel, and Perttula et al. (2003:14–15) illustrate a similar incised rim sherd from the Chupek site (41ML44) that they relate to Caddo utility ware. As noted in Appendix E, Vessel 1 is a Caddo-made pot likely from the Neches or Angelina River basin.

Vessel 2 is a medium to large jar with a probable everted rim and globular body. Sherds from this vessel were recovered from Excavation Units 40, 43 (n = 2), 45, 63, 81, 124, and 148; most of these units are in the central part of the block. They consist of eight grog-tempered body sherds. None refit, but they appear to be associated with one another based on a distinctive decoration and gray to black paste. They are decorated with tightly spaced curvilinear appliqué similar to that seen on Caddo vessels of the type Harleton Appliquéd (Figure 5.38a–b; Suhm and Jelks 1962:65). The sherds are all burnished on the interior, and three display burned incrustations suggesting that Vessel 2 also was used for cooking. Appendix E notes that Vessel 2 likely is from the upper Sabine River or Cypress Creek basin.

A single everted rim sherd with a rounded lip from Test Unit 19 may also be associated with Vessel 2. It is decorated with horizontal lines of fingernail punctations (Figure 5.38c) and has a paste color and tempering similar to that of the appliquéd sherds. Punctated rims do occur on Harleton vessels that have appliquéd bodies. Still, since this rim does not refit and has a different decorative mode, it is possible that it represents a different vessel. For instance, fingernail-punctated rims occur with brushed bodies on Caddo Bullard Brushed jars (Suhm and Jelks 1962:21).

Vessel 3 is represented by a rim and neck section of a small to medium-sized jar or olla. It consists of 12 undecorated sherds, 9 of which refit, from Excavation Units 23, 54, 57, 59, 62, 85, 95, 103, 130, 131 (n = 2), and 132. Most of these are in the southeastern part of the excavation block. Sherds refit between Excavation Units 54 and 95, 57 and 95, 85 and 95, 54 and 103, and 103 and 130 (Figure 5.38c), as well as Excavation Units 131 and 132 (Figure 5.38d). They are tempered with grog (n = 6) and grog and bone (n = 6), and they have finely burnished interior and exterior surfaces with a yellowish brown to black exterior and gray to black interior and core. The rim is everted and has a tapered lip. The neck appears shorter than that of Vessel 2, suggesting an olla or small jar form. There is no indication of burned incrustations on this vessel, and therefore it may not have been used for cooking. The vessel form and exterior color may be consistent with the classic Toyah type

Figure 5.38. Vessels 2 and 3. (a–b) Vessel 2 body sherds with curvilinear appliqué; (c) possible Vessel 2 rim with horizontal lines of fingernail punctations; (d) Vessel 3 rim and neck section with six sherds refitted; (e) Vessel 3 rim neck section with three sherds refitted.

Leon Plain (Suhm and Jelks 1962:95), but the grog temper and INAA evidence are not. Rather, Vessel 3 appears to be an imported Caddo pot from the upper Sabine River or Cypress Creek basin (see Appendix E).

In summary, the 43 sherds recovered from the Jayroe site represent a minimum of three vessels. None is complete enough to estimate its size, but one, a jar or olla, clearly was smaller than the other two, which likely were medium-sized or large jars. The medium to large jars appear to be cooking vessels, as their sherds display burned incrustations on their surfaces that probably represent food residues. All three vessels are Caddo-made pots from east Texas, with the Neches/Angelina, upper Sabine, and Cypress Creek basins being the most likely sources areas. Vessels 1 and 3 are untyped utility wares, and Vessel 2 is typed as Harleton Appliquéd. The 13 sherds not assigned to Vessels 1–3 may or may not be from these pots; if not, they indicate the presence of one or more other pots, possibly of the Caddo type Bullard Brushed.

Eleven sherds were selected for both instrumental neutron activation analysis (INAA) and petrographic analysis (see Appendixes B and C). Vessel 1 contributes a rim sherd (Lot 196) and a neck sherd (Lot 515). Vessel 2 contributes appliquéd body sherds (Lots 304 and 589) and possibly a fingernail-punctated rim sherd (Lot 130). Vessel 3 contributes 2 plain body sherds (Lots 364 and 613). Sherds not clearly associated with any of these vessels, although possibly from Vessel 1, consist of a brushed and incised sherd (Lot 175), 2 brushed body sherds (Lots 118 and 386), and a base sherd (Lot 125).

Prewitt and Associates contracted with Dr. Steve Tomka of Raba Kistner Environmental, Inc., to coordinate these studies, with the INAA samples sent to the Archaeometry Laboratory, Research Reactor Center, at the University of Missouri and the petrographic samples going to Lori Barkwill-Love at the University of Texas at San Antonio. Appendixes B and C contain those specialists' reports, and Appendix D contains Tomka's comments. After completion of those studies, Prewitt and Associates contracted with Dr. Timothy Perttula of Archeological and Environmental Consultants, Inc., to evaluate the results; his report, which is Appendix E, is the most comprehensive consideration of the subject.

The critical results of these studies are as follows: (1) the decorative elements on Vessels 1 and 2, and on sherds not assigned but possibly from these two jars, are the same as those found on Caddo utility wares made in the Neches/Angelina, upper Sabine, and Cypress Creek basins in east Texas in Late Caddo times, A.D. 1400–1680; (2) all of the 41HM51 vessels are tempered primarily with grog, with limited use of bone (mostly within pieces of grog), which links them technologically with Caddo ceramics rather than pottery made in central Texas by Toyah groups, who tempered their pottery mostly with bone; and (3) the 41HM51 sherds are more consistent in their chemical composition with pottery made in east Texas than that made in central Texas. In short, there is no doubt that all of the ceramics recovered are imports of Caddo-made wares.

BONE TOOLS AND MODIFIED BONES

The excavations yielded a small collection of bone awls or awl-like implements, cut or sawn bones with groove-and-snap marks reflecting bone tool manufacture, a polished canid canine, modified antler fragments, and a notched bone or rasp. These are described below.

Awls

The most common bone artifacts are awls, awl fragments, and items similar to awls. Represented are one complete specimen and six fragmentary examples (Figure 5.39a–b). Of the latter, one is proximo-medial, four are medial, and one is distal. These are unidentifiable to species or specific skeletal elements, but all appear to have been manufactured from longitudinal splinters of medium-sized to large mammal long bone shafts or metapodial fragments based on observed cortical thickness and interior remnants of medullary cavities. The complete specimen is a cortical bone splinter with the tip modified by abrasion and polish to create a sharp point (see Figure 5.39a). Lateral edges reflect helical or green bone fractures indicating that the splinter was removed from a fresh bone. Other than tip modification, the splinter is unmodified, although there does appear to be

Figure 5.39. Bone tools and modified bones. (a) Complete split bone awl; (b) bone awl fragment; (c) thick flat cortical portion with cut end; (d) grooved and snapped fragment; (e) polished canid tooth; (f) burned and polished bone fragment with zigzag incised design; (g) notched bone or rasp.

some surface and edge prehension polish and smoothing from use. All fragmentary specimens have more modified surfaces and vary from oval to round in cross section. One medial fragment exhibits rodent gnawing on the surface. The complete awl is 98.7 mm long, 10.3 mm wide, and 5.4 mm thick. The nearly complete proximo-medial fragment is 75.1 mm long, 12.7 mm wide, and 5.0 mm thick.

Modified Bone Fragments

This category consists of three pieces of faunal material that exhibit evidence of deliberate modification like application of the groove-and-snap technique or sawing. These modifications suggest use as raw material to manufacture artifacts. One fragment is a thick piece of bison-sized broad flat cortical bone (see Figure 5.39c); element is unknown. One end has been cut across the width by sawing from the inner and outer surfaces and then snapped. A longitudinal edge of the piece was modified similarly, and the exterior surface was ground or abraded adjacent to the transverse cut described above. Length is 61.6 mm; width is 34.7 mm; and thickness is 6.3 mm.

The second specimen is a long bone fragment of indeterminate animal size that was grooved and snapped on one end (Figure 5.39d). The technique was used to remove the articular end of the long bone and exposed the spongy bone inside the medullary cavity at the proximal end of the element. There are several small fine linear cuts adjacent to the groove that may be associated with butchery and disarticulation of the joint. The encircling groove cuts through the exterior thicker cortical bone surrounding the cavity. Length is 31.7 mm; width is 16.8 mm; and thickness is 8.1 mm.

A third fragment is a small piece of long bone shaft showing a portion of the medullary cavity; it is indeterminate as to element and animal size. The outer surface exhibits a small portion of the circumference with evidence of sawing or grooving and snapping.

Ornaments or Decorated Bones

A canid canine tooth exhibits microscopic multidirectional abrasion lines in linear clusters suggesting that it was polished on something like a sandstone slab (Figure 5.39e). No indications of perforation are present, but such could have been present on the end of the root portion now missing. This artifact may have been a pendant. The length of the tooth is 30.9 mm; width is 8.7 mm; and thickness is 4.9 mm.

A small polished piece of burned bone, perhaps an awl shaft fragment, exhibits a portion of a delicately incised zigzag design on one surface (Figure 5.39f). Element and animal size are unknown, and both ends are fractured. Length is 22.5 mm; thickness is 3.9 mm; and width is incomplete.

Modified Antler Fragments

Three small portions of antler tine may be modified or may be fragments of antler that were used as pressure-flaking implements based on distal tine wear. Two are tip fragments that exhibit blunting and bevel wear characteristic of that produced on tools used in pressure flaking. A third specimen is two refitting fragments of tine missing the tip that exhibits possible chopping marks on the thicker proximal end perhaps produced in removing the tine from the rack. All three antler artifacts appear to be burned.

Notched Bone or Rasp

One splinter of unidentified long bone has five shallow notches cut into one edge (Figure 5.39g). The notches are 4–6 mm apart and about 1 mm deep. This may be a small fragment of a musical rasp.

THE VERTEBRATE FAUNAL ASSEMBLAGE

As inventoried in Appendix A, the excavations yielded a total of 7,649 bones weighing 14,432.7 g[1]. Bone preservation was good to excellent, but some postdepositional taphonomic signatures are evident. Some elements exhibit varying amounts and intensities of weathering, such as longitudinal splitting, minor to

[1] This summary is drawn from the initial faunal analysis presented in Appendix A; it was prepared before the second analysis presented in Appendix J was done and thus does not reflect any of the results of that study.

moderate acid etching from rootlets, and what appears to be sporadic manganese staining. One notable characteristic is the degree of fragmentation. Only 177 bones (2.3 percent) are considered complete or nearly complete, and these are predominantly teeth, small carpals, metacarpals, tarsals, phalanges, and a few vertebrae or other similarly small compact bones. Quigg (see Appendix A) notes that the high proportion of small pieces in combination with multiple species of different body sizes made it difficult to assign fragmentary material to specific taxa. Most fragments are portions of midshafts (diaphyses) or else lack the appropriate diagnostic characteristics (proximal and distal ends) to achieve confident species (or in some cases even body size) assessments. This resulted in a large proportion of the assemblage remaining indeterminate as to taxon. More than half of the assemblage by count (n = 4,441; 1840.3 g) could not be identified to element. Long bones account for 768 fragments weighing 6,057.8 g. Also well represented are rib fragments (n = 1,242; 3,098.5 g) and various bones of the feet (n = 122; 1,480.5 g).

The degree of fragmentation is evident in the size-grade pattern of the assemblage. Size-grade information is available for 7,509 specimens (the difference between this number and the total assemblage count of 7,649 is due in part to refitted fragments that were considered as whole or larger partial skeletal elements). Of the 7,509 specimens, 86 percent are 0–3 cm in size, 9.9 percent are 3–6 cm, 2.2 percent are 6–9 cm, 0.6 percent are 9–12 cm, and 1.3 percent are greater than 12 cm.

Bison and Bison-Sized Remains

Remains positively identified as bison (n = 197, 5,560.5 g) and as bison-sized (n = 533, 4,341 g) constitute 9.5 percent of the entire assemblage and 27.6 percent of the identifiable assemblage (by count). A total of 706 mature, age-unknown, and old-age bison and bison-sized elements were categorized as complete elements; proximal, medial, and distal portions; and lateral and medial fragments (Table 5.6). Adjusting for refits lowers the total to 699. Of these, 17.1 percent are larger than 9 cm in length, 38.6 percent are 3–9 cm long, and 44.3 percent are 3 cm or less in maximum length. Element and body portion representation clearly illustrates the selectivity of the butchery process and what portions were returned to camp. It shows a clear preference for fore and hind limb and hump areas as opposed to the head (see Table 5.6).

Bison fetal, immature, and newborn/young remains are represented by only 17 specimens with the majority of these being fetal (n = 9, 112.3 g; Table 5.7). Of the 17 specimens, 5.9 percent are larger than 9 cm in length, 11.8 percent are 3–9 cm long, and 82.3 percent are 3 cm or less. Element representation for the fetal remains indicate that they most likely were returned to the camp whole rather than butchered. Newborn and young bison may have been processed under similar preferences and choices as mature bison.

Quigg (see Appendix A) derived a minimum number of individuals (MNI) of five bison based on skeletal analysis and a roughly equal number of males and females. At least nine proximal and distal ends of bison bones are intact enough to make MNI assessments and indicate that at least two mature male bison (two left

Table 5.6. Mature, old-age, and age-unknown bison and bison-sized elements by portion

Element	Whole	Proximal	Medial	Distal	Fragments	Total	Percent
Skull:							
Skull					1 (magnum)	1	0.1
Tooth	6				2	8	1.1
Vertebrae:							
Atlas					1	1	0.1
Vertebra			1		1	2	0.3
Spine			4			4	0.6
Rib		31	328		63	422	59.8
Front leg:							
Scapula		112				112	15.9
Humerus		7				7	1.0
Radius		3	1			4	0.6
Ulna			1			1	0.1
Scaphoid	1					1	0.1
Metacarpal	3					3	0.4
Rear leg:							
Pelvis					1	1	0.1
Femur		1	6	15		22	3.1
Tibia		1	14	3		18	0.3
Lateral malleolus	1		2			3	0.4
Cuneiform	4		1			5	0.7
Navicular cuboid	1					1	0.1
Calcaneus	1					1	0.1
Metatarsal		1		2		3	0.4
Other:							
Phalange, first	2			1		3	0.4
Phalange, second	1					1	0.1
Sesamoid (proximal and distal)	6					6	0.8
Metapodial		1				1	0.1
Unknown, cancellous, and long bones					75	75	12.3
Totals	26	157	358	21	144	706	100.0

distal metatarsals) and two females (two right radii) are represented. A newborn is indicated by a single metapodial. Fetal fragments indicate that at least one of the females was pregnant. Missing from the assemblage are cranial parts, mandible portions, and pelvises. As these are portions that are bulky with little meat, these animals likely were killed, skinned, and disarticulated at the kill site with selected portions brought back to 41HM51 for further processing.

The best indication of seasonality is the presence of newborn and fetal elements, which suggests that at least some of these bison were procured during late Spring. The bison remains are not especially informative about environmental conditions, as they could have been procured locally or during hunting trips to more-distant locales. If they were hunted locally, though, the butchery patterns would indicate that the kill sites were not very close to 41HM51.

Table 5.7. Fetal, newborn, and young bison and bison-sized elements by portion

Element	Whole	Medial	Distal	Fragments	Total	Percent
Skull:						
Mandible				1 (fetal?)	1	5.9
Skull				1 (fetal?)	1	5.9
Tooth	1 (fetal)				1	5.9
Vertebrae:						
Cap (unfused)			3		3	17.6
Front leg:						
Metacarpal		1 (newborn)			1	5.9
Rear leg:						
Femur		1 (fetal)			1	5.9
Other:						
Phalange, first	1 (newborn)				1	5.9
Unknown, cancellous, and long bones		7 (3 fetal, 2 newborn, 2 possible fetal)		1 (fetal)	8	47.0
Totals	2	9	3	3	17	100.0

The remains at 41HM51 represent the end of the sequence of processing, bone utilization, and breakage begun when the animals were killed. Hence, they provide only a partial picture of butchering and processing practices. During the analysis, cut marks, impact marks, spiral fractures, chop marks, and heat alteration were recorded to address these issues. Table 5.8 presents the results. Evident is the predominance of processing marks on front and rear leg elements, which coincides with offsite processing and return of selected elements to 41HM51. The high number of ribs with cut marks is characteristic of removing and segmenting the thoracic area, while impact and spiral fractures predominate on long bones. Examination of long bones with spiral fractures and impact scars revealed the presence of three specimens with anvil rebound stress pitting/fracture scars. The presence of these features indicates the use of a single anvil to break open long bones rather than supporting the ends between two anvils (Johnson 1985:210, 222). Each example of anvil rebound damage is opposite an impact fracture point or spiral fracture. Heat alteration on some long bones is concentrated along the midshaft and consists of light brown burning at areas of deliberate flaking and breakage. This indicates that heat was applied to fresh bone as an aid in removing the periosteum tissue, making breakage of the thick cortex of the diaphysis easier.

All of the butchering marks are on mature bison/bison-sized elements or those of indeterminate age. None are on fetal, newborn, or young/immature specimens. This indicates that young/fetal bison were processed differently than mature bison. Quigg and Peck (1995:115) note an identical pattern for the bison remains from the Rush site. They reason that young individuals may have been separated into smaller sections without cutting into the limb bones, or they may have been segmented via the vertebral column. None of the fetal/immature/young bison remains are burned. The distribution of rodent gnawing shows no real pattern other than a concentration on front and rear leg elements.

Table 5.8. Bison bone cultural and scavenger modification

Element	Impact fractures	Chop marks	Anvil rebound marks/scars	Spiral fractures	Cut marks	Heat altered	Rodent gnawing
Vertebrae:							
Atlas					1		
Cervical					1		
Thoracic					1		
Spine					1		
Rib	1			1	33		
Front leg:							
Humerus		1		2		3	3
Radius				3			1
Ulna					1		
Rear leg:							
Pelvis							
Femur	2	1	2	4	2		10
Tibia	1		1	4	2		1
Metatarsal	1			2	1		1
Navicular cuboid					1		
Other:							
Phalange, first					1		
Long bones	1	1		5	3		2
Totals	5	2	3	21	48	3	18

Note: Totals in cells indicate numbers of individual elements. Cell counts for cut marks indicate the number of elements and not the total number of individual cut marks.

Deer, Deer-Sized, and Pronghorn Remains

A total of 1,458 specimens (2,204.9 g) are included in the deer/pronghorn-sized portion of the assemblage, accounting for 19.1 percent of all recovered remains by count. Definite deer specimens total 536 (702.4 g), and 920 bones (1,497.2 g) are deer-sized. Only 2 specimens weighing 5.3 g (a single molar tooth and a third phalange) are identified as pronghorn, but it is possible that some of the deer-sized elements could be pronghorn as well. Of 1,453 sized specimens (accounting for refits), 0.7 percent are larger than 9 cm in length, 3.3 percent are 6–9 cm, 17.5 percent are 3–6 cm, and 78.5 percent are 3 cm or less in maximum length. Thus, 96 percent of deer/pronghorn remains are 6 cm or less in maximum dimension. This suggests a greater degree of fragmentation of deer long bone elements compared to bison, although the larger initial size of bison bones also likely plays a role in this difference. Table 5.9 shows the mature, old-age, and age-unknown skeletal elements categorized into complete elements; proximal, medial, and distal portions; and lateral and medial fragments. Apparent from these data is the greater representation of all major parts of the animal compared to bison, indicating that complete animals were brought back to camp for processing. There is also a predominance of medial portions and unidentified fragments.

Table 5.10 summarizes the immature and young deer and deer-sized remains, consisting of 52 specimens (290.5 g). The general profile is similar to that

Table 5.9. Mature, old-age, and age-unknown deer, deer-sized, and pronghorn elements by portion

Element	Whole	Proximal	Medial	Distal	Fragments	Total	Percent
Skull:							
Skull					313	313	22.5
Inner ear	1		3			4	0.3
Mandible							0.4
Tooth	27				7	34	2.4
Antler			86	4	9	99	7.1
Vertebrae:							
Axis			6			6	0.4
Lumbar					5	5	0.4
Caudal			1			1	0.1
Vertebra			7	1	8	16	1.1
Vertebral cap					1	1	0.1
Rib		1	344		53	398	28.6
Front leg:							
Scapula	1	3	7			11	0.8
Humerus				3		3	0.2
Radius		4				4	0.3
Ulna		1				1	0.1
Scaphoid	1					1	0.1
Metacarpal				1		1	0.1
Rear leg:							
Pelvis			2			2	0.1
Femur		1		1		2	0.1
Tibia			1	2		3	0.2
Patella	1					1	0.1
Astragalus	4					4	0.3
Lateral malleolus	1					1	0.1
Cuneiform	3		1		1	5	0.4
Navicular cuboid	3					3	0.2
Calcaneus							
Metatarsal		5	1	1		7	0.5
Other:							
Dew claw	4					4	0.3
Phalange, first	2	1		1		4	0.3
Phalange, second	5			1		6	0.4
Phalange, third	10	1	1		1	13	0.9
Phalange, fragment				7	2	9	0.6
Sesamoid (proximal and distal)	9					9	0.6
Metapodial		2	5	7		14	1.0
Long bones and Indeterminate			361	4	37	402	28.9
Totals	72	19	831	33	438	1,393	100.0

of subadult bison. Of the size-graded bones, 4.5 percent are larger than 9 cm, 24.3 percent are 3–9 cm long, and 71.2 percent are 3 cm or less in maximum length.

Counts of right and left sides and proximal and distal ends provides an MNI of three individuals. This is based on three right distal radii, three right

Table 5.10. Immature and young deer and deer-sized elements by portion

Element	Whole	Medial	Distal	Fragments	Total	Percent
Skull:						
Mandible		24			24	46.2
Maxilla	2 (1 complete, 1 in 11 fragments)				2	3.8
Tooth	4			1	5	9.6
Vertebrae:						
Vertebra		1			1	2.0
Rear leg:						
Tibia		8		4	12	23.0
Calcaneus	2		1		3	5.8
Metatarsal	3				3	5.8
Other:						
Metapodial			2		2	3.8
Totals	11	33	3	5	52	100.0

immature tibiae, and three immature calcaneii. At least one deer skull fragment has attached antler, which indicates at least one male with unshed antlers. Most antler fragments are medial sections or small tips, and it is not possible to tell if they were shed or attached. Mandible and maxilla segments, in situ teeth, and loose teeth are associated with animals of different ages. Some teeth in mandible and maxilla sections are from individuals young enough to attempt age estimations. Examination of tooth rows indicate at least one deer was 10–15 months old (based on the presence of heavily worn deciduous premolars with three cusps and an erupted M3). A second maxillary segment with worn molars indicates an older individual.

The skull fragment with unshed antler suggests that at least some procurement occurred during the Winter, as bucks often shed their antlers by the end of February. This would be consistent with the young deer noted above. White-tailed deer undoubtedly were hunted locally, and thus these remains are not particularly informative about environmental conditions.

As noted, fragment and element representation indicates that, unlike bison, whole animals were returned to camp for processing. Quigg (see Appendix A) suggests that deer and deer-sized remains were processed as intensively as bison based on the presence of impact fractures, spiral fractures, cut marks, and other butchery trauma indicators (Table 5.11). The limited number of intact proximal and distal ends of long bones also follows this pattern. The distribution of cut marks on elements indicates that they were likely produced during sectioning of joints or removal of selected pieces of meat from limb and thoracic areas. Intensive burning is prevalent on ribs. There is no indication of deliberate heat treatment of long bone elements prior to smashing for marrow extraction as is represented among bison remains.

Other Remains

The remainder of the assemblage is dominated by remains that are indeterminate in terms of taxon and element. Identifiable bones represent small

Table 5.11. Deer/pronghorn bone cultural and scavenger modification.

Element	Impact fractures	Chop marks, butchered	Spiral fractures	Cut marks	Burned	Rodent gnawing
Skull:						
Antlers					91	
Vertebrae:						
Atlas						5
Rib				5	126	
Front leg:						
Humerus		1	1			
Radius			1	1		
Rear leg:						
Pelvis				1		
Femur				1		
Tibia			1	2		
Metatarsal			4	1		
Astragalus				1		1
Other:						
Phalange, second		1				
Indeterminate and Long bones	5	5	6	22	28	
Totals	5	7	13	34	245	6

Note: Totals in cells indicate numbers of individual elements or fragments. Cell counts for cut marks indicate the number of elements and not the total number of individual cut marks.

mammals, birds, fish, and some reptiles (Table 5.12). Canid, dog, and coyote-sized animals are indicated by a complete metapodial and first phalange and proximal ends of a femur and scapula. The metapodial has a thick cut mark on one end suggesting the animal was killed and butchered. Rabbit and rabbit-sized fauna are overwhelmingly comprised of long bones, long bone fragments, and a small number of other elements such as teeth and lower limb elements. Two long bone fragment specimens exhibit spiral fractures. Two sizes are represented, jackrabbit and cottontail. One distal femur fragment is from an immature individual.

Three sizes of birds are present: turkey, duck, and smaller than duck. These remains are medial portions of long bones, distal humerii, a complete carpometacarpus, and a proximal coracoid. Three turkey-sized elements exhibit tiny cut marks and spiral fractures. Turtles are represented mainly by carapace fragments, a few small plastron portions, and a complete femur. There are no visible indications of cultural modification, and specific sizes and varieties of turtle are unknown. Fish remains consist of one otolith fragment, cranial and jaw fragments, and

Table 5.12. Other vertebrate taxa represented

Taxon	No.	Weight (g)
Birds and bird-sized	38	19.6
Turkey-sized	1	4.7
Canid and dog-sized	6	8.7
Dog/coyote and dog/coyote-sized	4	10.9
Rabbit and rabbit-sized	90	36.1
Raccoon-sized	1	1.4
Squirrel	2	0.8
Rodent and rodent-sized	36	4.3
Carnivore and carnivore-sized	9	15.1
Turtles	93	46.6
Snakes	9	1.0
Fish	165	89.4
Indeterminate	5,007	2,087.5
Totals	5,461	2,326.1

vertebrae. Quigg (see Appendix A) notes that catfish is present based on dorsal spines, mouth parts, and some of the larger vertebrae. Smaller fish are most likely represented by the smaller vertebrae and other elements.

Rodent and rodent-sized remains are common but are represented mainly by cranial, maxillary and mandibular fragments, and teeth with only a few long bone fragments. There is no indication that these remains represent food items, as none exhibit evidence of burning or butchering. Snakes are indicated by a few vertebrae, and squirrels are represented by long bone fragments. As with rodents, there is no indication that either of these taxa represent food items, and none are burned. The squirrel long bone fragments exhibit dry bone breaks.

None of these bones conveys much information about seasonality or environments. They would have been available year-round and in proximity to the site.

Fragmentation and Fracture Freshness Index Analysis

TxDOT's Work Authorization No. 57701SA003 (Task 3) specified that Prewitt and Associates would compile information on fracture patterns, following the methods of Outram (1998), using data from the faunal analysis presented in Appendix A. This section does that. That analysis recorded fragment size in 3-cm increments between 0 and 12 cm and noted that the materials are concentrated in the smaller size grades, hinting at the possibility that the assemblage had been subjected to intensive processing to extract marrow or render bone grease. That study did not consider the agents of fracture or the taphonomic history, however. The purpose of this study is to test the assumption that fragmentation is due to cultural agency for the purpose of rendering bone grease and extracting marrow.

Taphonomic Observations

Following the weathering criteria discussed by Behrensmeyer (1978), the Jayroe site faunal assemblage has entered at least Stage 1 weathering. Although evidence of perimortem spiral fractures reflecting marrow extraction are obvious, they are just one of several agencies of breakage observed. All material is dry, and a majority show some evidence of surface cracking parallel to the fiber structure, longitudinal in the case of long bones. In a number of cases, specimens with evidence of spiral fractures or other cultural modification also exhibit an array of attributes associated with dry bone breakage, weathering, and longitudinal splitting and surface pitting.

Rib segments, especially those of bison size, are also separating or have separated at the interface of the dorsal and ventral cortical surfaces, exposing the interior spongy bone. These elements also commonly exhibit longitudinal splitting and cracking. During the analysis discussed below, it was obvious that the assemblage contains many small rib fragments that had been subjected to breakage after cortical surface separation.

Elements are present that represent a continuum of weathering and fragmentation taphonomy that includes Behrensmeyer's (1978:151) Stages 2 through

4. Salient characteristics of these stages include cortical surface delamination, peeling, splintering, and increased longitudinal splitting/cracking. Articular surfaces tend to have been compromised at these stages and may expose the underlying cancellous bone. Cortical surfaces may have begun to develop patches of weathering, exposing underlying cortical layers and creating isolated to expanding/coalescing pitting of the surface. This was observed on some larger elements like bison-and deer-sized long bone ends and diaphyseal fragments and on the broad flat surfaces of scapulae and ribs. Some thinner and flatter elements appear to have been additionally fractured by overburden compaction (Lyman 1987:102).

Quigg (see Appendix A) recorded comments on a variety of observed taphonomic modifications that include both noncultural and human-induced (cultural) agencies. These are presented as total cases observed in Table 5.13. The fragmentation study below confirms the presence of these types of modifications. Noncultural modifications account for 23 percent of the observations, with rodent-chewing and weathering being dominant. Various types of cultural modifications occur on 77 percent of the modified bones. Burning and tool cut marks are most common.

Nearly absent is any indication that bones were exposed to water transport. Just seven bones were recorded as having rounded surfaces and edges attributed to this cause. Three other bones were noted to have rounding with no cause suggested, but it is uncertain if these were transported by moving water or had been subjected to carnivore digestive processes. There is no evidence of carnivore predation such as canine punctures or gnaw marks or scooping of cancellous material on any of the skeletal material, but all of these rounded fragments are small pieces that could have been ingested.

Table 5.13. Frequency of taphonomic phenomena in the vertebrate faunal assemblage

Taphonomic Modification	No.	Percent
Noncultural:		
Weathered	22	5.1
Rodent-chewed	41	9.6
Rounded	11	2.6
Waterworn or water-transported	6	1.4
Dry break	3	0.7
Root-etched	3	0.7
Dark-stained	12	2.8
Subtotal	98	22.8
Cultural:		
Burned	200	46.6
Heat-altered or heat-damaged	2	0.5
Spiral or helical fracture	35	8.2
Impact scar or imact point	11	2.6
Cuts or cut marks	78	18.2
Chop or chop marks	2	0.5
Groove-and-snap	2	0.5
Red-stained (ocher)	1	0.2
Subtotal	331	77.2
Totals	429	100.0

Concept and Methods of Fragmentation and Fracture Freshness Index Analysis

Faunal studies commonly address the proportion of bone that exhibits cultural modification. This includes elements that have been subjected to deliberate breakage to access interior bone marrow or to render bone grease. The main criterion for human-agent bone breakage is typically the presence of spiral fractures. Such fractures are created when fresh or essentially fresh bone is broken by application of dynamic forces (Bonnichsen 1979:42–44; Johnson 1985:170–180; Pickering et al. 2013; Villa and Mahieu 1991). Quite often, these are on portions of shaft fragments of long bones broken to expose the medullary cavity and marrow and portions of ribs broken during butchering. To more completely assess the importance of bone grease rendering and marrow extraction, additional observations on fragment size range, fragmentation agents, and types of fragments are necessary (Outram 2002a:51). To accomplish this, Outram (1998, 2002a) created a fracture freshness index (FFI), which accommodates large and fragmented assemblages, is quickly calculated, and "does not require a high level analytical skill" (Outram 2004:177). Outram (2002a:61) notes that "The Freshness Fracture Index was principally designed to identify marrow extraction from bone shafts. The same criteria cannot be used to assess fracture types on cancellous bone comminuted during grease extraction. However, the FFI, as well as helping to identify marrow extraction ..., also tells one much about post-depositional taphonomy. Hence, if most shaft fracture is fresh then it strengthens the argument that high levels of fragmentation associated with grease rendering were the result of that practice rather than post-depositional attrition, which would have resulted in more dry and mineralized fractures of shaft fragments. The FFI is thus used below in arguments relating to to both marrow extraction and grease rendering."

Three attributes of bone fracture are key to the the freshness fracture index. These are fracture outline, fracture surface texture, and fracture angle (Bonnichsen 1979:40–42; Johnson 1985:177; Villa and Mahieu 1991:34–40).

FRACTURE OUTLINE, FRACTURE SURFACE TEXTURE, AND FRACTURE ANGLE

Fracture outline describes the general shape of the fracture. Fresh bone is expected to fracture in a spiral pattern. Outlines not created while the bone is fresh are diagonal, transverse, and longitudinal. Combinations of all of these can occur on specimens that also exhibit characteristics of fresh bone breakage. Fresh fractures usually have smooth edges and surface textures, although some have localized areas of rough texture due to stress relief during breakage. Fracture surfaces of dry bones usually exhibit a granular surface texture. On freshly fractured bones, the angle of the fracture face in relation to the cortical surface is either acute or obtuse. Right angles are common on nonfresh breaks. Other features of nonfresh breaks include steps and columns where the fracture outline is interrupted by microcracks in the bone. Such microcracks are produced by loss of moisture.

Other features that are indicative of fresh fractures include impact points or scars, adhering bone flakes, flake scars, rebound pits or scars (from an anvil), and rebound stress features. In addition, freshly broken ribs have adhering splinters, depression fractures, and peeling where layers of external cortical bone are removed along with the periosteum during bending/breaking (Pickering et al. 2013).

FRACTURE FRESHNESS INDEX SCORING

The FFI is a sum of individual scores for fracture outline, fracture angle, and fracture surface texture. The index reflects whether breakage on a bone occurred when it was fresh, dry, or both. Evaluation of the three criteria occurs along a continuum. For each, a score of 0, 1, or 2 is given to a fragment or group of similar fragments in a lot. A score of 0 indicates attributes entirely consistent with fresh fracture. A score of 1 indicates the presence of some nonfresh features. A score of 2 indicates that nonfresh features predominate (Outram 1998, 2001a, 2001b, 2002a, 2002b, 2004).

For example, a fragment with no fracture surfaces at right angles to the cortical surface would score 0 for that criterion. If 40 percent of the fractures are at right angles, then it would score 1. If 50 percent or more of the fractures are at right angles, it would score 2. For fracture outline, the presence of only a spiral fracture means a score of 0, a mixture of fracture types means a score of 1, and a complete absence of spiral fractures means a score of 2. For fracture texture, 0 means an absence of roughness, 1 means some roughness but mainly smooth, and 2 means a largely rough texture.

Summing the scores for the criteria gives an index ranging from 0 to 6. A low index value indicates a specimen is consistent with fresh fracture, and a high index means the opposite. Scores of 0–2 are considered to represent bones broken in a fairly fresh state. Scores of 3–5 represent bones that were broken when becoming dry or bones that exhibit some elements of fresh fracture but were further fragmented when in a nonfresh state (Outram 2002b:34–35). A score of 6 represents faunal remains with no indication of fresh fracture.

SIZE GRADE ANALYSIS

The same sample used in the FFI study was also size-graded to look for patterns of fragmentation. The method of size-grading follows that used by Outram (1998). Data coded for each bone, fragment, or bone group (similar FFI) included provenience, quantity, weight, taxon, element, portion, whether the item is a complete bone or complete epiphysis, body portion, size grade, and observations on burning and other details. Observations noting distinctions between complete bones, complete epiphyses, and general body portion were based on recommendations by Outram (1998:160–162). Size grades were in 10-mm increments between 20 and 100 mm. Bones less than 20 mm or greater than 100 mm in maximum length were coded as such.

For provenience lots with multiple small bone fragments (if of same bone or all indeterminate), the totals of each size grade meeting certain FFI criteria were coded, weighed, and counted together where possible. This meant that the fragments coded together all shared the same FFI profile and other characteristics. In most cases, this was not feasible, but when possible it enabled the analyst to somewhat control inflated noncultural fragmentation numbers caused by agents such as soil compression, trampling, or separation of cortical surfaces. Elements such as ribs and scapulae are particularly susceptible to such taphonomic changes and can skew the fragmentation results.

Bone Marrow, Bone Grease, Bone Fragmentation, and Element Selection

Ethnographic and archeological studies indicate that marrow extraction and bone grease rendering have long been important economic and subsistence activities on the Plains of North America (Church and Lyman 2003; Creel 1991; Karr et al.

2008, 2010; Ritterbush 2002; Ritterbush and Logan 2009; Scheiber 2007; Vehik 2002; Wolverton et al. 2008). Both activities involve further processing of bones after the meat is removed, but the results differ, as do the elements used. Bone shafts contain marrow, epipyphyseal cancellous bone contains one type of bone grease, and axial cancellous bone contains another type (Outram 2001b:403). Binford (1978a:32) makes a distinction between yellow and white grease, with the former being the most desirable. White grease is high in oleic acid while yellow grease is poor in oleic acid, and hence axial cancellous bone is seldom selected for grease rendering. Production of bone grease is a much more laborious process than marrow extraction, requires more planning since suitable elements have to be stockpiled (until enough are on hand to make it worth the effort), might be less feasible in warmer climates (due to spoilage of stockpiled materials), and has greater technological requirements (container, water, and heat). All that marrow extraction requires is breaking bones up enough to scrape out the fat.

Multiple researchers have ranked skeletal elements of taxa the size of bison and deer according to their value for providing marrow and grease (Bar-Oz and Munro 2007; Binford 1978a; Karr et al. 2008; Lupo and Schmitt 1997; Madrigal 2004; Morin 2007; Ritterbush and Logan 2009; Todd and Rapson 1988; Wolverton et al. 2008). These studies indicate that upper and lower appendicular elements (long bones, metapodials, metatarsals, first phalanges) with rich reservoirs of marrow in their medullary cavities and spongy articular ends were selected initially for marrow and bone grease (white grease) extraction. Secondary elements such as ribs, mandibles, and vertebrae were chosen to augment sources of bone grease (yellow grease). These elements were often broken and completely reduced in the process.

One aspect of bone grease production that has been generally assumed in the literature is that increased fragmentation (smaller sizes) increases the efficiency of grease rendering, the amount of grease rendered, or both (Church and Lyman 2003:1077). Greater fragmentation is considered by some to be an efficient way to increase surface area and obtain more grease. Church and Lyman's (2003:1078) brief literature review indicates that fragment size can range between 1 and 7–8 cm, a considerable span. Their experimental results of bone fracture, boiling, and grease rendering suggest that about 80 percent of total extractable grease can be rendered from fragments about 5 cm in maximum dimension (Church and Lyman 2003:1083). Their data indicate that the amounts of grease obtained from bones in lots 1, 2, and 4 cm in maximum size were not appreciably different over boiling times spanning 14 hours. In other words, fragmentation increased the amount of rendered grease up to a point, beyond which the amount obtained was negligible for the amount of energy expended.

Janzen et al. (2014) proposed an interesting interpretation of fragmentation following Church and Lyman's (2003) study. They conducted bone fragmentation and boiling experiments to render grease from cattle femora in size lots of 1, 2, 4, and 5 cm. Their results suggest that a benefit of increased fragmentation is that it requires less water. Their experiments suggest that the work that it takes to produce an assemblage of small fragments is a positive tradeoff in that less fuel, less water, and less human energy are required to render the grease.

Stewart's (2005, 2011) research at the site of Dunefield Midden in South Africa suggests that there may be a technological link between fragmentation size and boiling technology as well, and ethnographic observations of Kalahari and Hadza campsites indicate that boiling technology significantly affects bone size because the bones have to be processed enough to fit within cooking vessels (Kent 1993; Oliver 1993; Yellen 1991a, 1991b). Yellen (1991b:302–303) notes specifically that the size of kudu long bone fragments boiled by Ju/'hoansi women is influenced by pot size.

Stewart (2011) and others indicate that increased intensity of bone fragmentation for grease rendering and nutrient extraction typically includes use of such low-yield elements as mandibles, compact bones, and phalanges (Bar-Oz and Munro 2007; Gifford-Gonzalez 1993; Lupo and Schmitt 1997; Munro and Bar-Oz 2005). At the Dunefield Midden site, Stewart (2011) noted a distinct difference in the intensity and patterning of fragmentation and processing between large bovid skeletal elements and smaller bovid/artiodactyls. Large bovid long bone ends with substantial amounts of cancellous spongy bone were processed more extensively to maximize grease production. Outram (2001a, 2001b:402) associates the processing of elements such as long bone ends, mandibles, and phalanges with intensive processing to retrieve marrow from cancellous portions.

Bone Fragmentation and Fracture Freshness at the Jayroe Site

The size-grade and FFI analysis was done on 1,240 bones weighing 3,090.7 g. This represents 16 percent of the total assemblage by number and 21 percent by weight. The sample was selected from 18 excavation units (57 provenience lots, all representing the Toyah component). Nine of the units (Excavation Units 44, 46, 75, 87, 97, 127, 133, 146, and 153) are in the main concentration of faunal remains in the east-central part of the block (see Chapter 6 for spatial analysis). These units have high quantities (by weight) of bison, deer/pronghorn, or unidentified bones. The other 9 analyzed units (Excavation Units 92–94, 106, 140, 148, 149, 151, and 155) are in three secondary concentrations of bison, deer/pronghorn, and unidentified bones in the northeast and northwest corners of the block and the southwest quadrant.

FRAGMENTATION EXTENT AND INTENSITY

The first step in the study was to size grade the sample using 10-mm increments as discussed above, with complete elements and long bone epiphyses as a category unto itself since they clearly have not been broken for either marrow extraction or bone grease production. Following Outram, the data are presented in bar graph form showing total mass per size grade (Figure 5.40). The distribution exhibits a gradually decreasing total mass from smaller to larger size grades except for the largest size class (>100 mm), which has significantly more bone than any other class. A full 57 percent (1,940 g) of the analyzed faunal material is in the largest size class and the whole element/epiphysis category.

This pattern is not characteristic of faunal assemblages interpreted as having been processed extensively for bone grease (Karr et al. 2010; Outram 2002a, 2002b). An excess of large bones and whole elements and epiphyses indicates that this

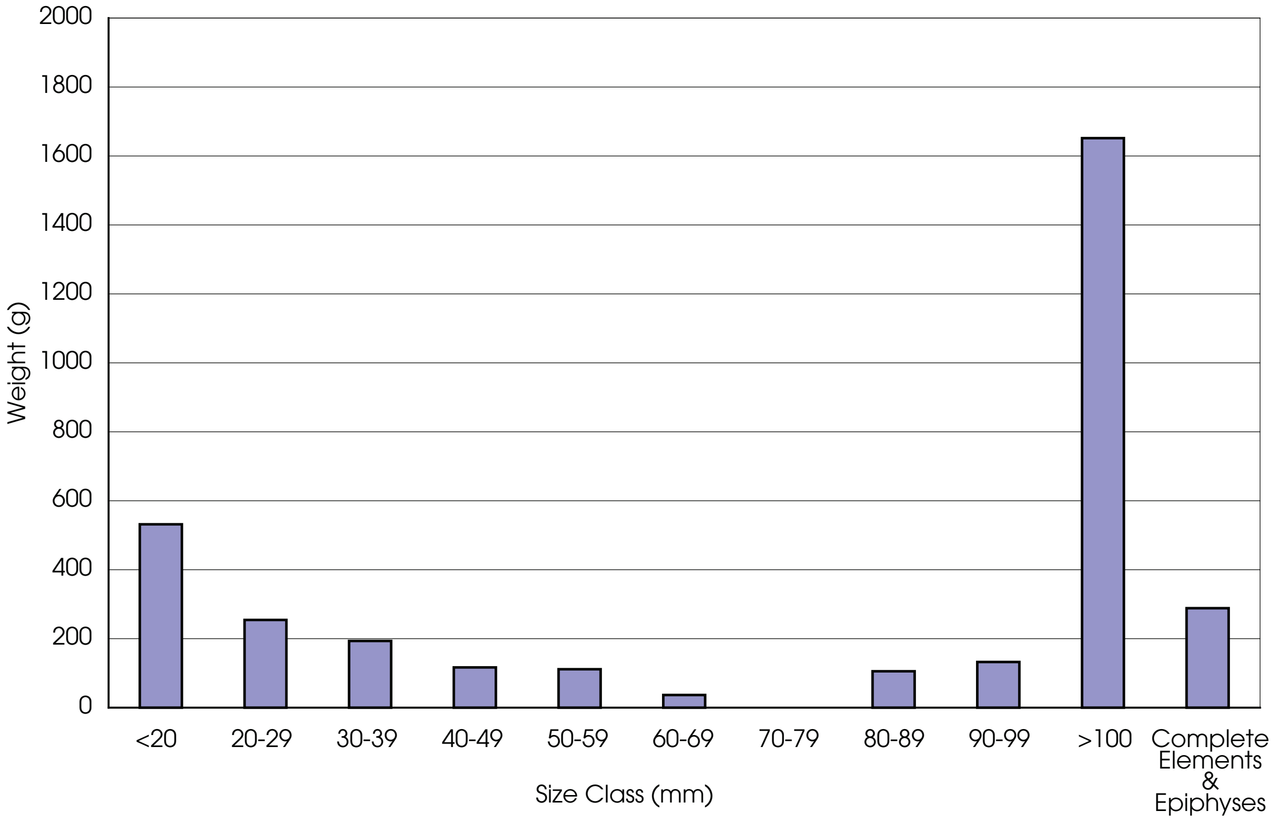


Figure 5.40. Graph of total bone weight per size class.

material remained intact and was not processed extensively, in effect representing unrealized potential sources of bone grease. These categories include intact or nearly intact articular proximal and distal ends of long bones that would have been good sources of secondary bone marrow. The 41HM51 data are comparable to those for the early component at the Mitchell Prehistoric Indian Village site in South Dakota, where Karr et al. (2010:218) reason that the presence of such large amounts of bone in these categories indicates that, although significant amounts of bone fat were available, the inhabitants disregarded those sources. For that component, 78 percent of the bone material was larger than 100 mm or whole elements or epiphyses. In contrast, the assemblages from two later contexts at that site had more small fragments, with only about 18–24 percent being larger than 100 mm or in the whole element/epiphysis category. Karr et al. (2010:219–221) interpret the later assemblages as reflecting much more intensive processing to extract bone grease.

FRACTURE FRESHNESS INDEX

Figure 5.41 depicts the distribution of the total analyzed assemblage in terms of FFI scoring. Two-thirds of the bones have a score of 6, meaning they were not fresh when they were broken. Just 18 percent have the lowest score representing fresh fractures. Hence, for the assemblage as a whole, it is clear that most breakage is noncultural. The numbers are affected, however, by the inclusion of elements such as ribs and scapulae, which delaminate and splinter readily due to weathering. Further, the inclusion of taxa and elements that are unlikely to have been exploited for marrow or bone grease makes it hard to see evidence of those activities. Removing ribs, vertebrae, teeth, mandibles, maxillae, cranial elements, fish elements, and turtle elements and including only fragments of long bone diaphyses, proximal and distal ends of long bones, and indeterminate fragments presents a somewhat different picture (see Figure 5.41). Bones with only nonfresh breaks are still frequent (31 percent), but so are ones with only fresh breaks (35 percent). Together, the materials with the three lowest FFI scores (0–2) account for nearly half (48 percent) of the assemblage. Clearly, a significant proportion of the bones of animals butchered there were subjected to further processing. The question of what kind of processing this was can be addressed by looking at the two main prey species, bison and deer/pronghorn, since these are the bones most likely to have been broken for marrow or to produce grease.

Figure 5.42 presents FFI data (but as percentages rather than counts) only for bison and deer/pronghorn (and bison- and deer/pronghorn-sized elements), eliminating the indeterminate fragments included above. Both groups have abundant nonfresh breaks, but fresh breaks are much more common on deer/pronghorn bones than bison bones. Clearly, deer were processed more extensively or in a different manner than bison. Examination of the deer/pronghorn long bones (femora, tibiae, humeri, radii, and metatarsals/metapodials) indicates that they were broken primarily for marrow extraction, while the cancellous proximal and distal ends, which would have been good candidates for grease production, are still largely intact. Also intact and not processed for grease are the compact bones of the feet. This is true for the bison bones as well, but they were not exploited for marrow as much as the deer/pronghorn bones. It is hard to know why bison and deer/pronghorn bones were treated differently, but one possibility is that they resulted from separate occupations that differed in terms of things like seasonality, duration, or time constraints. The generally larger initial size of bison bones also could have played a role. Maybe the larger bones were harder to break, or less breakage was needed to reach the marrow.

The FFI pattern that other researchers have interpreted as indicating intensive marrow extraction and bone grease rendering is different than that depicted in Figures 5.41 and 5.42. In those cases, materials with fresh fractures predominate, and there is little evidence of nonfresh breakage. Those graphs are heavily skewed to the left. This is depicted in the datasets for the middle and late components of the Mitchell Prehistoric Indian Village site in South Dakota (Karr et al. 2010:219, Figure 2) and the Paleo-Eskimo site of Itivnera (Outram 2002b:35-37, 37, Figure 4), for example.

Summary

The original analysis of the 41HM51 faunal assemblage concluded that the bones had been subjected to intensive processing to extract marrow and render bone grease (see Appendix A). That study did not consider the agents of fracture or the

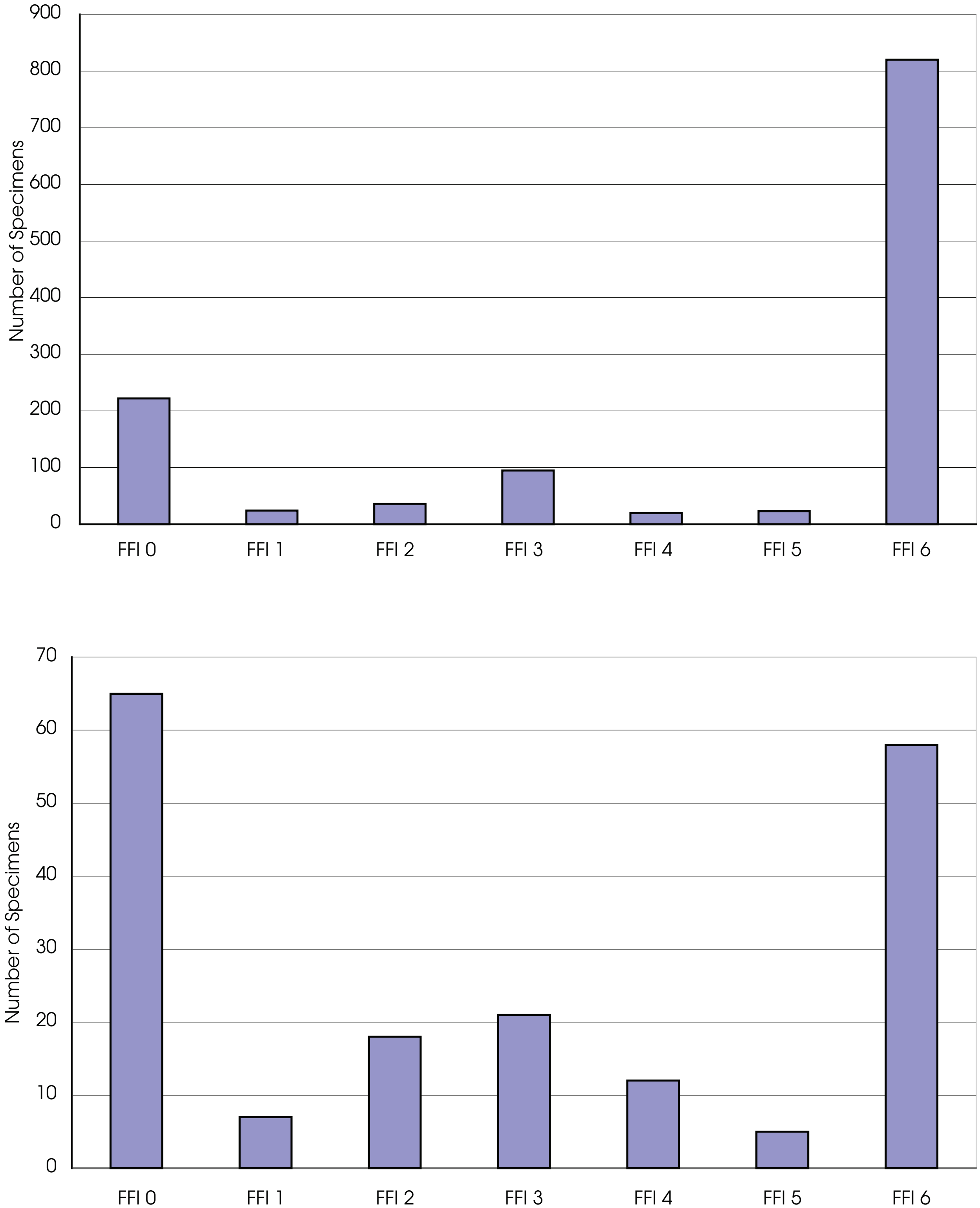


Figure 5.41. Graphs of FFI scores for the total analyzed sample (upper) and the subsample consisting of fragments of long bone diaphyses, proximal and distal ends of long bones, and indeterminate fragments (lower).

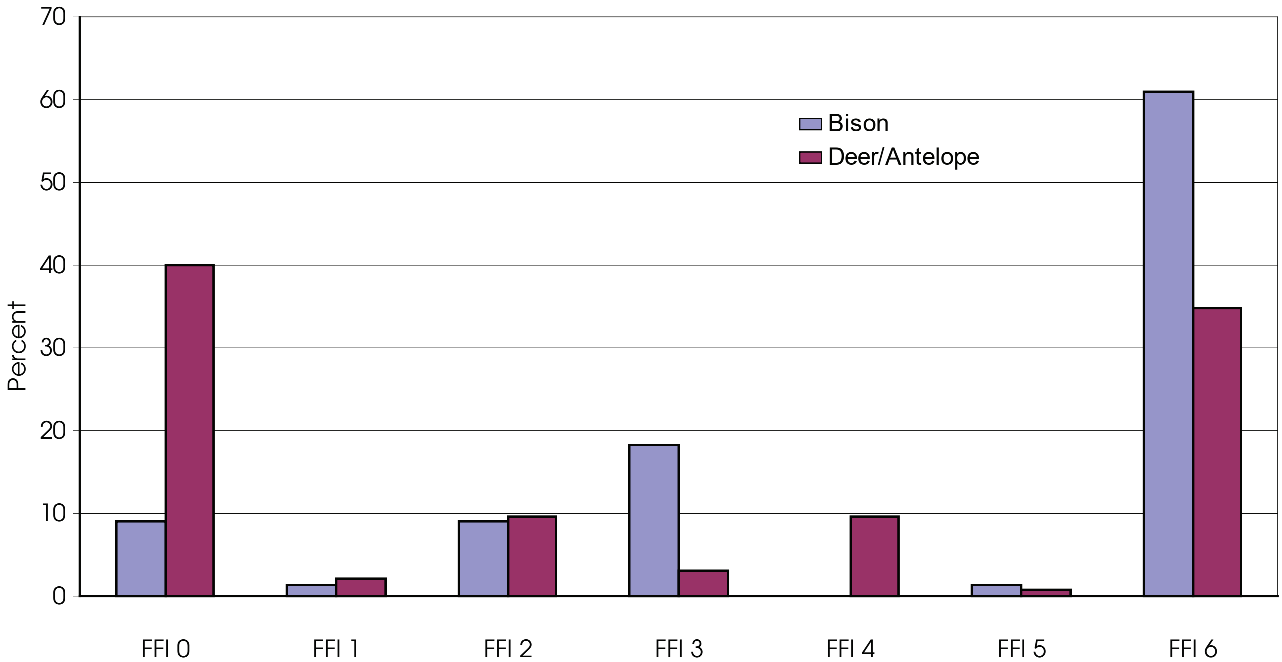


Figure 5.42. Graphs of FFI scores (as percentages) for bison and deer/pronghorn (and bison- and deer/pronghorn-sized elements).

taphonomic history, however, and including that information leads to a different conclusion. Much of the mass of the assemblage is tied up in large bones or whole elements/epiphyses, inconsistent with the idea of intensive processing, and much of the breakage that did occur is due to weathering or other noncultural factors. Consideration of just the taxa and elements most likely to have been exploited for marrow or grease reveals that deer/pronghorn and bison bones were processed differently, with the former broken in a fresh state much more often.

It is concluded that the intentional breakage in both deer/pronghorn and bison was associated mostly with marrow extraction rather than grease rendering, based on the abundance of whole terminal foot bones, including phalanges, and proximal and distal ends of long bones that are sufficiently complete to be identified (Table 5.14). These are elements that are often selected in cases of intensive grease rendering, which ultimately renders them unidientifiable.

THE INVERTEBRATE FAUNAL ASSEMBLAGE

Methodology

Freshwater mussels and land snails were analyzed to provide information on the range and variety of species found at the site (Table 5.15). Only intact valves and umbo fragments of freshwater mussels were analyzed, since body fragments are not typically suitable for identification and do not contribute to an accurate assessment of the assemblage. The small number of complete land snails was also analyzed to species for habitat information.

Table 5.14. Whole and fragment representation of selected fore and rear limb elements of bison and deer/pronghorn

Element	Whole	Proximal	Medial	Distal	Fragment
Bison, Front Leg:					
Scapula		112 (1 element)			
Humerus		7			
Radius		3	1		
Ulna			1		
Scaphoid	1				
Magnum					1
Metacarpal	3				
Bison, Rear Leg:					
Femur		1	6	15	
Tibia		1	14	3	
Lateral malleolus	1		2		
Cuneiform	4		1		
Navicular cuboid	1				
Calcaneus	1				
Metatarsal		1		2	
Bison, Other:					
Phalange, first	2			1	
Phalange, second	1				
Metapodial		1			
Deer/Pronghorn, Front Leg:					
Scapula	1	3	7		
Humerus				3	
Radius		4			
Ulna		1			
Scaphoid	1				
Metacarpal				1	
Deer/Pronghorn, Rear Leg:					
Femur		1		1	
Tibia			1	2	
Patella	1				
Astragalus	4				
Lateral malleolus	1				
Cuneiform	3		1		1
Navicular cuboid	4				
Metatarsal		5	1	1	
Deer/Pronghorn, Other:					
Dew claw	4				
Phalange, first	2	1		1	
Phalange, second	5			1	
Phalange, third	10	1	1		1
Phalange, fragment				7	2
Metapodial		2	5	7	

The shells were identified using comparative literature, mussel identification guides, and the Prewitt and Associates comparative collection. Each shell was identified to the genus and species level, unless the condition or fragmentary nature

Table 5.15. Mussel species identified and their preferred habitats and substrates

Genus	Species	Common Name	Total	Percent	Total Burned	Habitat	Substrate
Amblema	plicata	Threeridge	407	33.9	1	Small streams to large rivers, lakes, reservoirs	Mud, sand, clay, or gravel
Cyrtonais	*tampicoensis*	Tampico Pearly mussel	6	0.5		Slow-moving rivers to swifter streams, some reservoirs	Combination of mud, sand, and fine gravel
Lampsilis	sp.		47	3.9			
Lampsilis	teres	Yellow Sandshell	161	13.4		Small streams to large rivers	Mud to rocks
Potamilus	*purpuratus*	Bleufer	11	0.9		Quiet pools to slow-moving deep-water streams, large rivers	Mud or mud and gravel
Quadrula	*apiculata*	Southern Mapleleaf	28	2.3		Still-water reservoirs and slow-moving canals to swifter streams and rivers	Mud, sand, gravels, and cobbles
Quadrula	houstonensis	Smooth Pimpleback	31	2.6		Rivers	Combination of mud, sand, and fine gravel
Quadrula	*petrina*	Texas Pimpleback	14	1.2		Slower-moving rivers	Mud and gravel, sand and gravel
Quadrula	sp.		10	0.8	2		
Tritogonia	verrucosa	Pistolgrip	84	7.0	2	Medium-sized to large rivers	Sand, coarse gravels, or mud
Unidentified			401	33.4	5		
Totals			1200		9		

of the shell made confident identification questionable. A shell was considered unidentifiable when the fragment was too small, too fragmentary, or too poorly preserved for definite identification. Since valves were not identified to side (left or right), all counts indicate the number of individual valves rather than a representation of the number of individual animals present. Each shell was also examined for any evidence of intentional modification or for indicators of heating or burning.

Analysis Results and Species Descriptions

Freshwater Mussels

Most shells were identified to at least the species level, with a small percentage being identified only to genus and some being considered unidentifiable. As shown in Table 5.15, *Amblema plicata* is the dominant species, followed by *Lampsilis teres*. Other identified genera and species occur only in very minor proportions. Only a very small percentage (0.8 percent) exhibits any evidence of burning. Such a low proportion of burned shell suggests that the burning is incidental. None of the shells analyzed showed any indication of intentional modification.

All of the shells are freshwater mussels belonging to the Family Unionidae. Information specific to each genus and species is provided, including common name, range of occurrence, and preferred habitats.

Amblema plicata (Threeridge) is a common Texas species, found throughout central and east Texas. It ranges from the San Antonio and Guadalupe Rivers into other drainage basins to the north and east (Howells et al. 1996:34). This species is adaptable, having been documented in a variety of locations, from small streams to large rivers, as well as in lakes and reservoirs. Usually found at water depths of 1 to 3 ft, it favors a variety of substrates including mud, sand, clay, gravel, or combinations of these (Cummings and Mayer 1992:40; Howells et al. 1996:34; Parmalee and Bogan 1998:63).

Cyrtonaias tampicoensis (Tampico Pearly-mussel) has been documented in Texas in parts of the Rio Grande, Nueces, Frio, San Antonio, Guadalupe, Colorado, and Brazos drainage systems (Howells et al. 1996:48). An adaptable species, it has been found in a range of locations, from slow rivers to swifter-moving streams, as well as in some reservoirs. This species favors substrates that are made up of a combination of mud, sand, and gravel, although it has occasionally been found on cobble or rock surfaces. It is rarely found on substrates comprised of deep silt or shifting sands (Howells et al. 1996:49).

Lampsilis teres (Yellow Sandshell) is another common Texas species, found in all of the major river systems. It is an adaptable mussel, having been documented at depths ranging from 12 to 15 ft, in large and small streams and rivers, and in slow to fast currents. It is found on many different substrates, from mud to rocks, although it appears to avoid deep and shifting sand substrates (Howells et al. 1996:69–70; Parmalee and Bogan 1998:138).

Potamilus purpuratus (Bleufer) is found from the Gulf Coast drainages, including the Guadalupe River basin, into systems to the north and east. Documented through central and east Texas in both small and large streams and rivers, this species prefers quiet pools or deep-water streams with slow-moving waters. It favors stable substrates such as mud or mud and gravel (Howells et al. 1996:101; Parmalee and Bogan 1998:201).

Quadrula apiculata (Southern Mapleleaf) is common throughout most of Texas, except in west Texas and the Panhandle. An adaptable species, it has been found in still-water reservoirs, the slow-moving water of canals, and flowing waters of rivers and streams, usually on surfaces of mud or a combination of mud, sand, gravel, and cobbles. It has been documented at a variety of depths, ranging from less than 3 ft up to 15 ft or more (Howells et al. 1996:106; Parmalee and Bogan 1998:210).

Quadrula houstonensis (Smooth Pimpleback) has been documented in the Colorado and Brazos drainage basins. This species is typically found on substrates composed of mixed mud, sand, and fine gravel (Howells et al. 1996:112–113).

Quadrula petrina (Texas Pimpleback) is found in the Guadalupe and Colorado River systems. It has been found on mud and gravel substrates, as well as on sand and gravel. It appears to prefer slow-moving rivers and is found at depths ranging from 1 to 3 ft (Howells et al. 1996:119–120).

Tritogonia verrucosa (Pistolgrip) is documented in the San Antonio River system and drainages to the north and east (Howells et al. 1996:136–138). This species prefers substrates made up of sand, coarse gravels, or mud, and has been found in medium-sized to large rivers at depths ranging from 1 to 20 ft (Cummings and Mayer 1992:26; Howells et al. 1996:137; Parmalee and Bogan 1998:235).

Habitat Preferences

The freshwater mussel species identified at the site are all found in Texas, and all are documented in the major and minor drainages of central and east Texas. Although there are some variations in the types of habitats and substrates preferred, all inhabit similar environments and have proven adaptable to living in a range of circumstances. They all also have been identified in archeological contexts in central Texas such as at 41MM340, 41MM341, and a series of sites along the North Bosque River (Gardner 2006, 2008; Howells et al. 2003). The two most-common species, *Amblema plicata* and *Lampsilis teres*, have similar habitats and substrate preferences, allowing for the possibility that they may have been collected or harvested from a common location. The absence of such species as *Megalonaias nervosa* (Washboard) can be explained by the general absence of suitable habitat and substrate, since it prefers slower-moving deep rivers. The scarcity of *Cyrtonaias tampicoensis* (Tampico Pearly-mussel) and *Potamilus purpuratus* (Bleufer) can be attributed to an absence of preferred habitat of quiet pools in slow-moving deep-water streams and large rivers.

Terrestrial Snails

Eight complete specimens of land snail were collected during the excavations. Six are *Rabdotus dealbatus dealbatus* (Whitewashed rabdotus), and two are *Mesodon roemeri* (Texas Oval). *Mesodon roemeri* prefers habitats under rocks, leaf litter, and logs on wooded slopes near streams. *Rabdotus dealbatus* prefers riparian woodland habitats. Both of these species would be quite common in the environment surrounding 41HM51. Given the low number, it is likely that these are incidental inclusions rather than food sources.

Macrobotanical Remains

Prewitt and Associates submitted 7 carbon samples, 5 botanical lots, and 15 flotation samples (representing 106 cubic decimeters of feature fill) to Dr. Leslie L. Bush for analysis; Appendix F contains her report. The carbon samples and botanical lots yielded solely wood charcoal, with elm (probably cedar elm) being most abundant, followed by pecan or other hickory and white group oak. All of these grow in the area today and would have been common on the Leon River floodplain in the Late Prehistoric period. Taxa that are much less frequent are blackhaw, elm/hackberry, hackberry, mulberry, and plateau live oak. Likewise, the flotation samples yielded mostly white group oak, elm (probably cedar elm), and hickory (probably pecan). Other wood taxa are mulberry, hackberry, hawthorn, ash, blackhaw, dogwood, and soapberry. Most of these would be expected on the Leon River floodplain, but some (oaks, elm, and hackberry) occur in uplands also, and blackhaw grows in rocky or sandy woodlands. These all represent woods used as fuel at the site, although some of these trees produce nuts or fruits that could have been exploited. Examples of this consist of 45 pecan nutshells and 1 acorn shell and 2 hawthorn seeds. The only other non-wood plant parts are a sedge seed and a fragment of an Indian breadroot tuber. The latter likely represents a food source, while the former may indicate use of sedges in basketry.

CHAPTER 6: SITE ORGANIZATION AND ACTIVITIES

This chapter looks at the kinds of cultural features, artifacts, and ecofacts at the Jayroe site, and the spatial arrangement of these remains, to identify the kinds of activities Native Americans performed there and hence site function. Preceding this is a section that defines analytical units for the site and discusses their chronology.

ANALYTICAL UNITS AND CHRONOLOGY

As recognized at the completion of testing, the Jayroe site consists mostly of a Toyah phase component associated with a paleosol buried as much as 2 m beneath the modern floodplain surface. In both phases of work, cultural features and concentrations of debris, mostly chipped stone tools, debitage, and animal bones, were observed emanating from or lying upon the surface of that paleosol in configurations implying a high degree of contextual integrity (see Figures 5.8, 5.9, and 5.14). Not all of the cultural materials were so tightly tethered to that surface, though, with appreciable numbers of artifacts found just below it and above it as well. This section explores what the distribution of the cultural materials says about the history of site use and the best way to group proveniences for interpretation, concluding with an analysis of the chronology of the site based on radiocarbon dates and diagnostic artifacts and assignment of proveniences to analytical units.

Nature of the Paleosol Surface

As discussed in Chapter 4, the paleosol is a cumulic soil that caps the older alluvial unit under the T_{1a} terrace surface north of the Leon River. Above it is younger fill that is ca. 0.7 m thick near the T_{1a}/ T_{1b} terrace scarp in Trench 4 about 35 m south of the data recovery block and ca. 2 m thick at the north edge of the block. The paleosol surface slopes down from southwest to northeast, away from the river. Within the block, it drops about 1 m in elevation over a distance of 20 m (Figure 6.1). Its topography suggests some minor rilling of the surface in the central part of the block, but no evidence of this was observed in the field. Based on the topography, the nature of the paleosol, and the cultural materials associated with it, it is clear that the older alluvial unit is a constructional feature, the surface of which is largely intact. There is no indication that that surface was modified in any substantial way by erosion prior to deposition of the younger fill.

Figure 6.2, which provides a southwest-northeast (upslope-downslope) cross section through the block showing debitage and animal bone amounts relative to the top of the paleosol, illustrates this. In 8 of the 12 of the units making up this cross

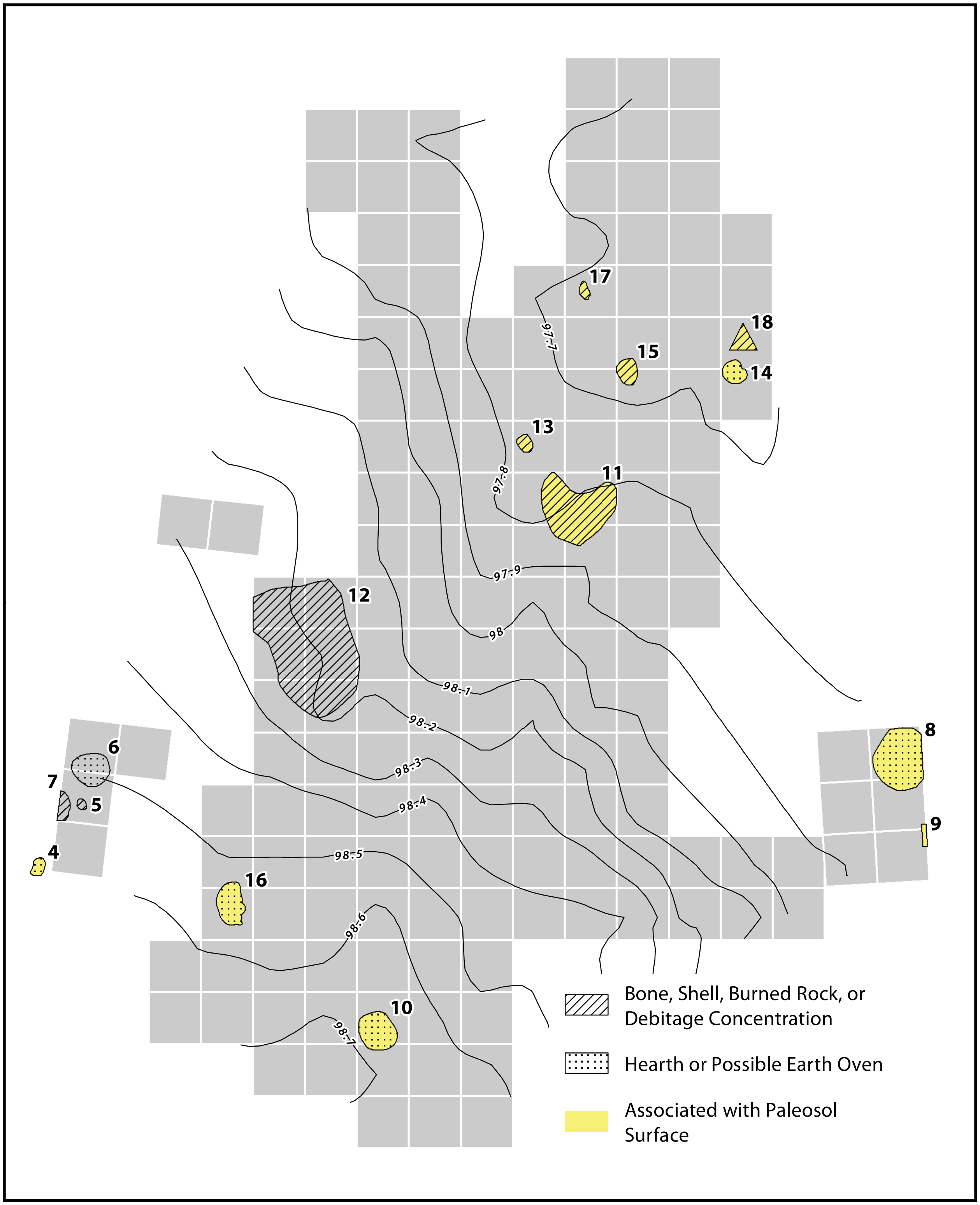


Figure 6.1. Topographic map of the surface of the paleosol (contour interval is 10 cm).

section, debitage counts are highest in levels coinciding with the paleosol surface; in 3 units, the highest counts are one or two levels above that surface, and the maximum count in 1 unit is just below it. Bone weights are slightly more distributed, with the greatest values in levels coinciding with the top of the paleosol in 4 units, just above it in 2 units, and just below it in 5 units. Given that the elevations for the top of paleosol are averages over a sloping surface and were reconstructed from unit notes that often refer to a bioturbated transition zone between the two units, it is not surprising that the congruence between the top of the paleosol and maximum abundance of cultural materials is not perfect. What these data do make clear is that the sloping nature of the surface is not the result of truncation of it by erosion.

Distribution of Cultural Materials Relative to the Paleosol Surface

To gain a broader understanding of the relationships between the cultural deposits and the paleosol, the records for the 671 levels (10 cm) excavated in the block and vicinity (including Test Units 7, 8, and 10–19) were reviewed so that they could be classified as follows: (1) contact levels, i.e., those levels that contain deposits of both the paleosol surface and the overlying alluvium; (2) levels that are entirely within the upper alluvium; and (3) levels that are entirely below the paleosol surface. Most of the units (n = 109) have a single contact level, but some (n = 41) have two because of the sloping nature of the paleosol surface, and a smaller number (n = 15) have none because that surface coincides perfectly with a break between levels or excavation started below it. Contexts above the contact levels are labeled A1 through A4 (from lowest to highest), and those beneath it are labeled B1 through B10 (from highest to lowest). Because the data recovery work focused on the 30–50 cm of deposits bracketing the top of the paleosol, the amount excavated is greatest in the contact levels (19.1 m^3) and the A1 and B1 levels (15.4 and 14.2 m^3). Excavated volumes decrease rapidly beyond that (Table 6.1). The only excavations that sampled the B3 levels or deeper were units dug during testing.

Table 6.1 quantifies the amounts and densities of various classes of cultural materials in the data recovery block and nearby test units relative to the paleosol surface, grouped by the context categories defined above. The seven features shown are just the hearths and possible earth ovens (Features 4, 6, 8–10, 14, and 16). Materials from the other eight features (Features 5, 7, 11–13, 15, 17, and 18) are lumped with general level recovery, since they are concentrations or scatters of occupational debris (bones, mussel shells, burned rocks, or flakes) rather than constructed facilities. Table 6.1 shows that almost all categories of cultural materials, including six of the seven features, are markedly concentrated in levels associated with the contact between the upper and lower alluvial units and the levels immediately above and below it. The only remains with different distributions are mussel shells (whole shells or fragments with umbos) and burned rocks, both of which are densest in the lower deposits sampled only in test units. As discussed below, these lowermost deposits appear to contain a very sparse Late Archaic component about which little can be said because data are so sparse.

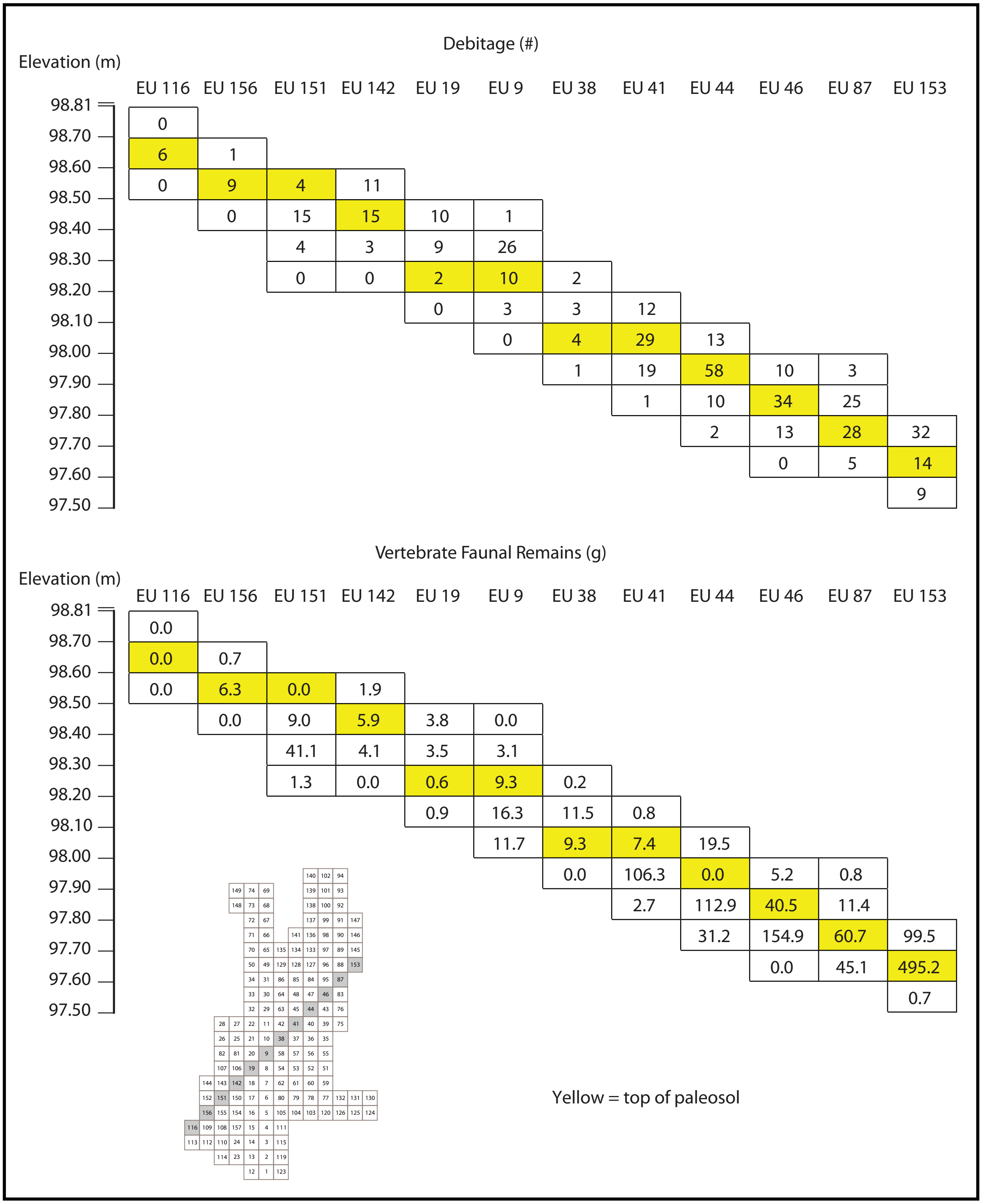


Figure 6.2. Southwest-northeast cross section through the excavation block showing debitage and animal bone densities relative to the paleosol surface (levels intersecting the top of the paleosol are highlighted).

Table 6.1. Vertical distribution of various classes of cultural materials in the data recovery block and nearby test units relative to the paleosol surface

			Debitage		Total Chipped Stone Tools		Vertebrate Faunal Remains		Mussel Shells		Burned Rocks		Perdiz & Preforms		Sherds		
Context	Volume	No. of Features	(#)	(#/m3)	(#)	(#/m3)	(g)	(g/m3)	(#)	(#/m3)	(kg)	(kg/ m3)	(#)	(#/m3)	(#)	(g)	(g/m3)
A4	0.2	0	0	0	0	0.0	0.0	0.0	0	0	0.0	0.00	0	0.0	0	0.0	0.0
A3	1.2	0	14	12	0	0.0	0.1	0.1	2	2	0.3	0.25	0	0.0	0	0.0	0.0
A2	8.3	0	488	59	29	3.5	239.3	28.8	31	4	5.3	0.64	8	1.0	2	7.6	0.9
A1	15.4	0	1834	119	61	4.0	2798.2	181.7	126	8	17.4	1.13	11	0.7	8	44.9	2.9
Contact	19.1	5	3216	168	190	9.9	7655.0	400.8	350	18	44.0	2.30	30	1.6	23	181.3	9.5
B1	14.2	1	628	44	33	2.3	2612.0	183.9	251	18	16.2	1.14	3	0.2	9	33.4	2.4
B2	5.1	1	68	13	2	0.4	887.9	174.1	144	28	6.3	1.24	1	0.2	0	0.0	0.0
B3	1.0	0	17	17	0	0.0	52.8	52.8	38	38	3.5	3.45	0	0.0	0	0.0	0.0
B4	0.6	0	8	13	0	0.0	2.1	3.5	8	13	0.8	1.33	0	0.0	0	0.0	0.0
B5	0.5	0	0	0	0	0.0	18.9	37.8	13	26	1.0	2.00	0	0.0	0	0.0	0.0
B6	0.4	0	6	15	1	2.5	7.8	19.5	12	30	1.7	4.25	1	2.5	0	0.0	0.0
B7	0.4	0	0	0	1	2.5	1.4	3.5	12	30	0.8	2.00	0	0.0	0	0.0	0.0
B8	0.3	0	0	0	1	3.3	7.1	23.7	32	107	0.9	3.00	0	0.0	0	0.0	0.0
B9	0.3	0	0	0	0	0.0	12.4	41.3	47	157	2.4	8.00	0	0.0	0	0.0	0.0
B10	0.1	0	0	0	0	0.0	0.8	8.0	4	40	0.3	3.00	0	0.0	0	0.0	0.0

Figure 6.3 graphs the densities of the main categories of materials (minus features, mussel shells, and burned rocks), omitting the lowermost ca. 60 cm (B5–B10) where little excavation was done. In these graphs, maximum values per category have been adjusted so they are nearly equal to allow easier comparisons between the lines. Three of the graphs are for categories of materials considered to represent general occupational debris: debitage, total chipped stone tools, and vertebrate faunal remains. The other two are for the two largest categories of artifacts that are temporally diagnostic of the Toyah phase: Perdiz arrow points/preforms and ceramic sherds. All five graphs show the same predominant pattern consisting of a strong peak in the contact levels, moderate densities in the one or two levels just above and below, and consistently low densities in the two levels farthest above and below the contact. Clearly, the vast majority of the cultural materials relate to a single period of occupation associated with the surface of the older alluvial unit. Five of the constructed cultural features originated at this surface: Features 8–10, 14, and 16. Feature 4 found 9 cm below the top of the paleosol in the bottom of Trench 7 probably originated there as well. No features originated in the levels above the contact, and just one, Feature 6, originated in the levels below it, 21 cm below the paleosol surface.

Feature 6 is not the only evidence for occupation of the site during the late stage of accumulation of the lower alluvial unit. Feature 5 just to the south of it is a concentration of burned rocks that appears to represent a dump of hearth debris; its base is ca. 29 cm below the top of the paleosol, 8 cm deeper than the top of Feature 6 pit. In addition, Feature 12 is a large, dispersed concentration of mussel shells lying 3.7 m northeast of Feature 6; at 18–23 cm below the paleosol surface, its context is comparable to Features 5 and 6. This occupation also may explain why the density of vertebrate faunal remains levels off in B2 contexts rather than continuing to decrease as do those for the other remains.

Although features are lacking in the levels above the paleosol surface, some of the artifact distributions suggest that occupation of the site continued as the upper alluvial unit began to accumulate. This could explain the moderate densities of chipped stone tools and Perdiz points and preforms in particular in A2 contexts and the more-modest slope of the debitage graph compared to the others. While it is possible that most of the materials in A2 contexts (and higher) got there via bioturbation, the fact that densities of debitage, chipped stone tools, and Perdiz points all are higher in A2 levels than in B1 levels argues otherwise. Rather, it appears that the ca. 40 cm of deposits consisting of the contact between the upper and lower units, the 20 cm just above it, and the 10 cm just below it contain the remains of a series of occupations over a fairly brief period of time, with one of those occupations probably contributing most of the features and the vast majority of the artifacts. The levels assigned to these contexts (i.e., A2 through B1) yielded 98 percent of the debitage and chipped stone tools, 96 percent of the Perdiz points and Perdiz preforms, 100 percent of the sherds, and 93 percent of the vertebrate faunal remains from the excavation block. Adding in the B2 levels increases the debitage, chipped stone tools, and vertebrate faunal remains to 99 percent and Perdiz points and preforms to 98 percent.

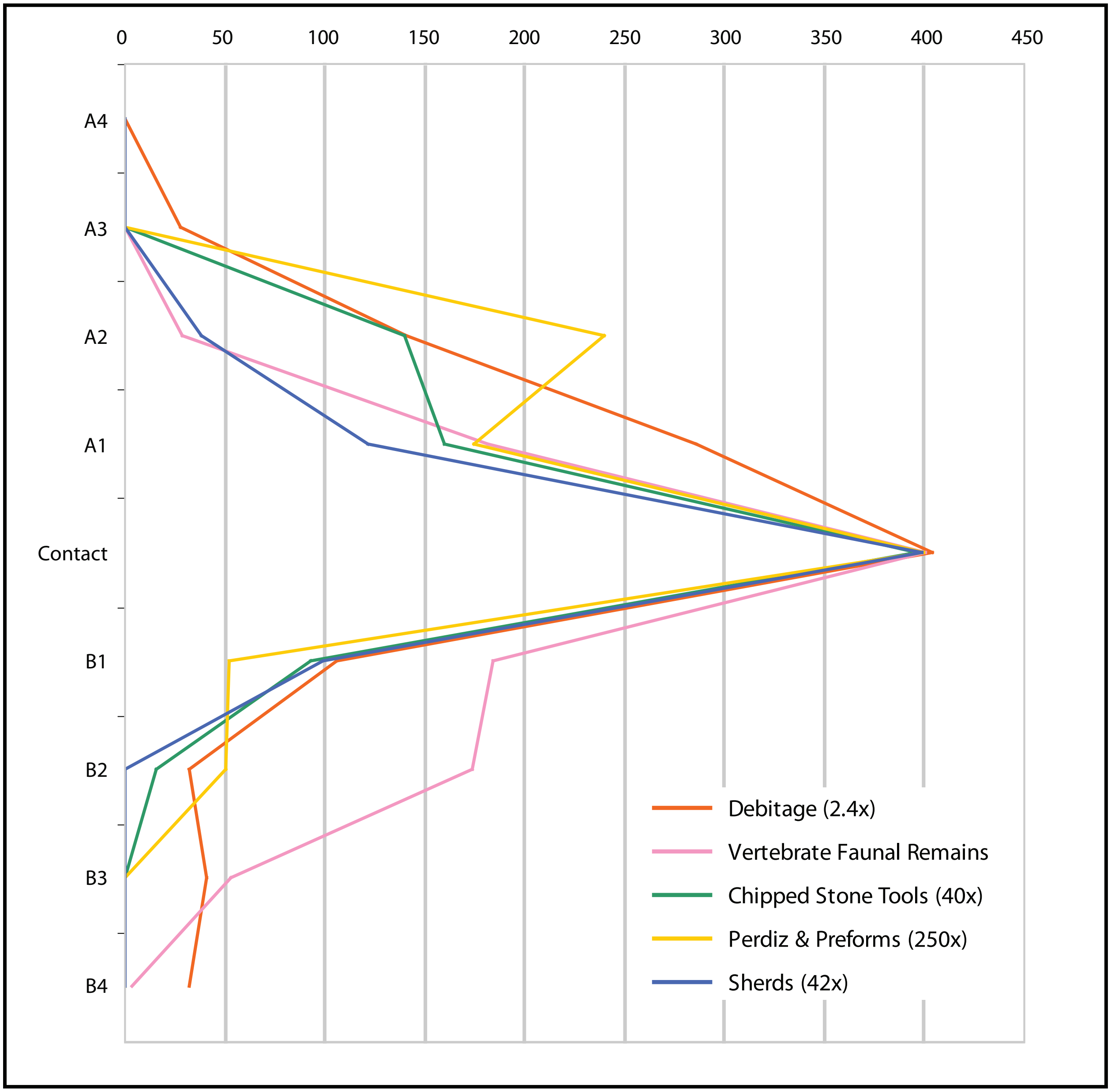


Figure 6.3. Graphs of the vertical distributions of various classes of cultural materials in the data recovery block and nearby test units relative to the paleosol surface and the deposits ca. 40 cm above and below it.

Temporally Diagnostic Artifacts

The temporally diagnostic artifacts indicate that the main occupation was confined to the latter half of the Late Prehistoric period. The predominance of Perdiz points and preforms among the arrow points supports this, as does their distribution and their association with the ceramic sherds, all of which are from Late Caddo pots. Arrow points typical of occupation earlier in the period are limited to two Scallorn points from a contact level and a B1 level. The only other typeable arrow points are a Cuney and a Harrell/Washita, both consistent temporally with Perdiz points and both from contact levels. A single terminal Archaic Darl dart point, from an A1 level, is clearly out of place.

Radiocarbon Dates

Twenty-four radiocarbon dates were obtained (Table 6.2). Twelve are from contexts that can be associated most confidently with the paleosol surface. Ten of these (9 on wood charcoal and 1 on charred tuber) are from the five possible earth ovens originating at that surface; all have evidence of in situ burning. The others are from nonfeature bison bones found lying at the top of the paleosol. The two-sigma calibrated ranges (using OxCal v4.3.2) cover a long time span from A.D. 1292 to 1663 (excluding one very low-probability range in the late 1700s), but 11 have higher-probability ranges that overlap at A.D. 1470–1476 (Figure 6.4); the early end of the higher-probability range for the twelfth date, on bison bone, is A.D. 1492. This set of dates argues that the main Toyah occupation occurred in the A.D. 1470s, with additional occupation perhaps a few decades later.

Of the other 12 dates, 5 are from concentrations of animal bones or burned rocks recorded as Features 11, 13, and 15 at the top of the paleosol, but the facts that they are on small pieces of potentially mobile charcoal and are from debris scatters rather than constructed features raise doubts about their contextual integrity. One of these 5 (UGA-15197; Feature 11) is consistent with occupation in the late A.D. 1400s, but 3 are earlier (UGA-15196, UGA-15201, and UGA-15205; Features 11, 13, and 15), and 1 is later (UGA-15199; Feature 13). The late date must reflect recent charcoal introduced by bioturbation, as its highest-probability interval is A.D. 1717–1890. Of the 3 early dates, 2 have high-probability intervals of A.D. 1295–1454 and 1390–1450 and thus predate the better-context dates associated with the paleosol surface by at least two decades. They may indicate stabilization of that surface and sparse Toyah phase occupation by mid-century. The third date has high- and moderate-probability ranges of A.D. 1257–1324 and 1346–1394; it most likely reflects introduction of early noncultural charcoal by bioturbation.

Two dates are on wood charcoal from Feature 12 (UGA-15198 and UGA-15204), a mussel shell concentration found 18–23 cm below the top of the paleosol. As above, there are reasons to doubt the contextual integrity of the materials dated, but based on the dates discussed above, the distributional evidence presented above, and the diagnostic artifacts, it is reasonable to think that the occupation that created Feature 12 occurred sometime during the first half of the A.D. 1400s. Both dates would be consistent with this interpretation, although one, with a high-probability interval of A.D. 1410–1525, feels better than the other, with a single range of A.D. 1270–1401. The only other date that is earlier than the late A.D. 1400s main Toyah occupation is from possible earth oven Feature 6, the top of which is 21 cm below the top of the paleosol. The higher-probability interval of A.D. 1386–1442 overlaps both of the Feature 12 dates, supporting the idea of early Toyah occupation as deposition of the lower alluvial unit reached its end.

Table 6.2. Radiocarbon dates

Lab Number	Provenience	Material	Conventional Age B.P. (13^{C} value)	Calibrated Calendrical Date, Two-Sigma Range (probability)
UGA-13208	BHT 7, 98.46 m (Feature 4)	wood charcoal	390+/-40 (-25.97)	A.D. 1436–1529 (60.8%) and 1544–1634 (34.6%)
UGA-13209	TU 8, 98.22 m (Feature 6)	wood charcoal	540+/-40 (-25.08)	A.D. 1307–1363 (37.3%) and 1386–1442 (58.1%)
UGA-13210*	TU 17, 97.71 m (Feature 8)	wood charcoal	310+/-40 (-25.07)	A.D. 1470–1655 (95.4%)
UGA-13211*	TU 17, 97.70 m (Feature 8)	wood charcoal	460+/-60 (-25.57)	A.D. 1318–1352 (5.1%), 1390–1525 (76.9%), and 1557–1633 (13.3%)
UGA-13212*	TU 16, 97.77 m (Feature 9)	wood charcoal	440+/-50 (-25.06)	A.D. 1405–1524 (79.4%) and 1558–1632 (16.0%)
UGA-15194*	EU 14, 98.58 m (Feature 10)	wood charcoal	500+/-70 (-25.37)	A.D. 1292–1520 (92.2%) and 1592–1620 (3.2%)
UGA-15195*	EU 14, 98.55 m (Feature 10)	wood charcoal	300+/-50 (-25.67)	A.D. 1465–1666 (93.7%) and 1785–1795 (1.7%)
UGA-15196	EU 48, 97.75 m (Feature 11)	wood charcoal	530+/-60 (-24.74)	A.D. 1295–1454 (95.4%)
UGA-15197	EU 48, 97.72 m (Feature 11)	wood charcoal	290+/-50 (-24.51)	A.D. 1458–1670 (91.3%), 1781–1799 (3.7%), and 1945–1949 (0.4%)
UGA-15198	EU 81, 98.00 m (Feature 12)	wood charcoal	430+/-50 (-27.25)	A.D. 1410–1525 (75.0%) and 1557–1633 (20.4%)
UGA-15199	EU 85, 97.71 m (Feature 13)	wood charcoal	210+/-50 (-26.70)	A.D. 1524–1559 (3.4%), 1631–1710 (26.8%), 1717–1890 (49.2%), and >1910 (16.0%)
UGA-15200*	EU 153, 97.61 m (Feature 14)	wood charcoal	400+/-50 (-24.11)	A.D. 1428–1530 (60.2%) and 1539–1635 (35.2%)
UGA-15201	EU 96, 97.51 m (Feature 15)	wood charcoal	690+/-40 (-23.79)	A.D. 1257–1324 (62.9%) and 1346–1394 (32.5%)
UGA-15202*	EU 156, 98.48 m (Feature 16)	wood charcoal	480+/-40 (-25.56)	A.D. 1327–1343 (2.6%) and 1394–1476 (92.8%)
UGA-15203*	EU 156, 98.46 m (Feature 16)	wood charcoal	500+/-50 (-24.44)	A.D. 1307–1363 (18.0%) and 1385–1477 (77.4%)
UGA-15204	EU 25–28 and 81–82, 98.11–97.92 m (Feature 12)	wood charcoal	660+/-50 (-25.93)	A.D. 1270–1401 (95.4%)
UGA-15205	EU 85, 97.80–97.70 m (Feature 13)	wood charcoal	510+/-40 (-25.73)	A.D. 1318–1352 (14.7%) and 1390–1450 (80.7%)
UGA-15206*	EU 145 and 153, 97.62–97.55 m (Feature 14)	wood charcoal	380+/-40 (-27.14)	A.D. 1441–1530 (55.2%) and 1540–1635 (40.2%)
Beta-403192*	TU 17, 97.82–97.61 m (Feature 8)	charred tuber	390+/-30 (-15.9)	A.D. 1441–1524 (69.3%), 1559–1562 (0.5%), and 1571–1631 (25.6%)
Beta-403193*	EU 48, 97.81–97.78 m	bison bone	340+/-30 (-8.3)	A.D. 1470–1640 (95.4%)
Beta-403194	EU 148, 97.70–97.60 m	bison bone	270+/-30 (-8.1)	A.D. 1514–1599 (42.8%), 1617–1669 (46.4%), and 1781–1799 (6.2%)
Beta-403195*	EU 153, 97.70–97.60 m	bison bone	290+/-30 (-10.9)	A.D. 1492–1602 (64.6%) and 1615–1663 (30.8%)
Beta-403196	EU 59, 98.20–98.10 m	bison bone	290+/-30 (-8.7)	A.D. 1492–1602 (64.6%) and 1615–1663 (30.8%)
Beta-403197	EU 83, 97.73 m	bison bone	310+/-30 (-8.5)	A.D. 1485–1650 (95.4%)

*Dates from best contexts most securely associated with the paleosol surface.

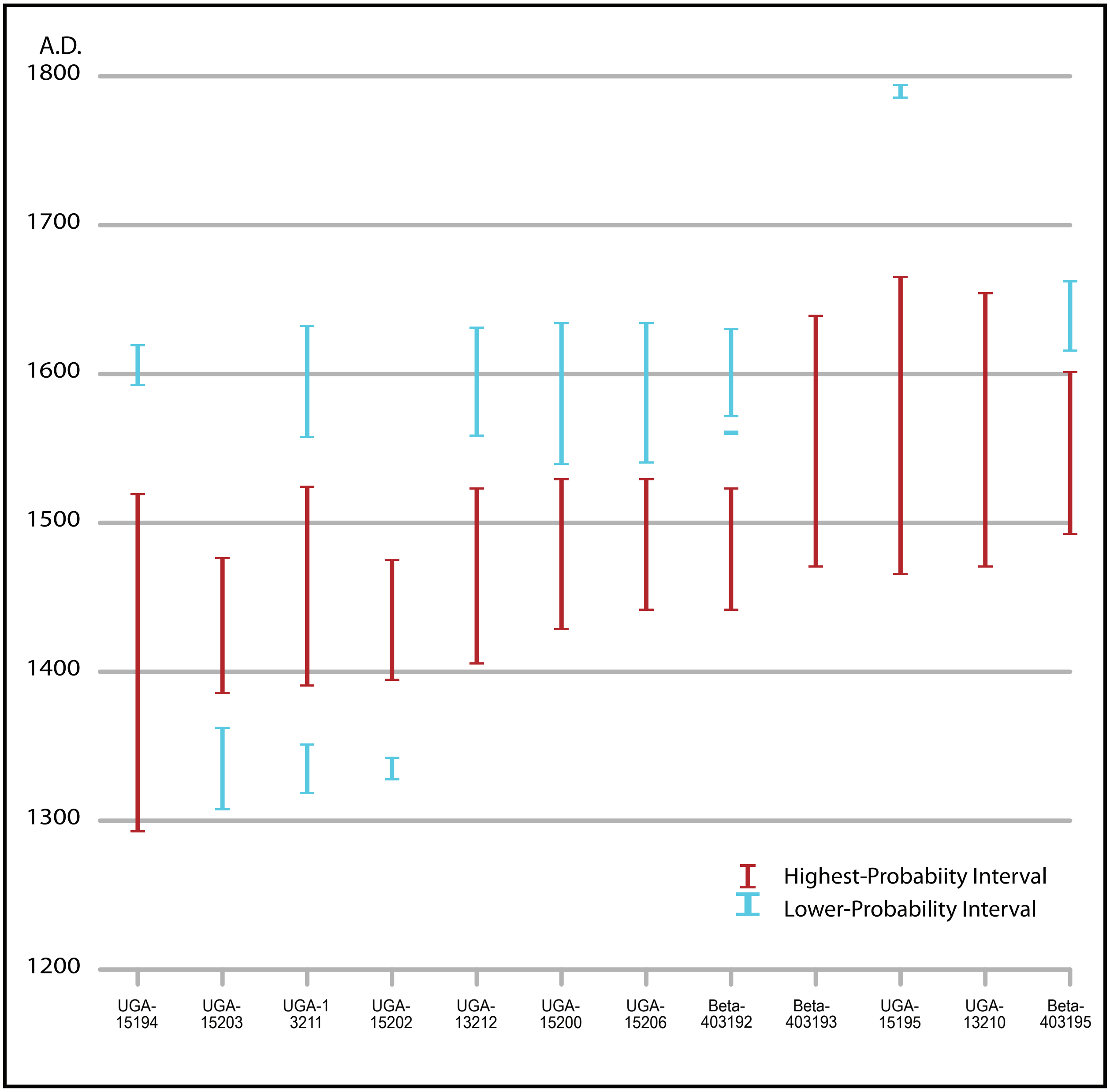


Figure 6.4. Graph of calibrated ranges of the 12 radiocarbon dates that can be associated most confidently with the paleosol surface.

Three of the final four dates are consistent with the paleosol-associated dates from better contexts. One is on wood charcoal from Feature 4 (UGA-13208), which almost certainly was dug from the paleosol surface but was found in the bottom of Trench 7 about 9 cm below it; its higher-probability range is A.D. 1436–1529. The other two are on nonfeature bison bones. One, from the upper 10 cm of the palesol (Beta-403197), has a single range of A.D. 1485–1650. The other, from the bottom 10 cm of the upper alluvial unit just above the paleosol surface (Beta-403196), has a higher-probability range of A.D. 1492–1602.

The final date is on bison bone from the uppermost part of the lower alluvial unit, but clearly below the contact with the upper unit (at least 10 cm below the paleosol surface). Based on this context and the other dates, it would be reasonable to expect that this bone should date to the mid A.D. 1400s, but it has two moderate-probability ranges considerably later than this (A.D. 1514–1599 and 1617–1669). It appears likely this sample was contaminated by the addition of later carbon from an unknown source.

In summary, 21 of the 24 radiocarbon dates are useful for reconstructing the chronology of the Jayroe site. The 3 that are not appear to reflect introduction of earlier and later charcoal by bioturbation and addition of later carbon to a bone sample via an unidentified source. Of the 21 dates, 13 suggest that the main occupation was in the A.D. 1470s. Three others point to probably lighter occupation perhaps two decades later; these could, in fact, be much later than this (they overlap at A.D. 1492–1602), but their contexts (they are associated with the paleosol surface and the deposits immediately above and below it) indicate otherwise. Subjectively, it seems unlikely they date after the early A.D. 1500s. The other 5 dates are broadly consistent with some light Toyah phase occupation in the first half of the A.D. 1400s shortly before accumulation of the lower alluvial unit ceased. These dates do not allow the timing of these occupations to be narrowed down any, however.

Evidence for Pre-Toyah Phase Occupation

Although not supported by radiocarbon evidence, it seems certain that the site has a very sparse Late Archaic component. This is indicated by the relative abundance of mussel shells, some recorded as Feature 7, at ca. 70–90 cm below the paleosol surface, associated with burned rocks and an Ensor dart point. There are no other artifacts from this context, though, so its interpretive potential is limited. It is hard to know how to interpret the sparse cultural remains in the 40 cm of late Holocene alluvium (B4–B7 levels) above the Late Archaic levels and below the levels with Toyah phase materials. These deposits contained no features and yielded just 28 pieces of debitage, 3 chipped stone tools (1 of which is a clearly intrusive Perdiz point or preform), and sparse vertebrate faunal remains, mussel shells, and burned rocks. These sediments likely were deposited in Transitional Archaic or early Late Prehistoric times, but it is impossible to know whether the cultural materials relate to occupations then or were introduced from above by bioturbation.

Definition of Analytical Units

Four analytical units are defined to encompass the excavated proveniences, although only one of these—the Toyah phase component—has any interpretive potential. The Toyah unit is distinguished in 12 test units and all 153 units in the data recovery block (Table 6.3). All levels assigned to A2, A1, contact, B1, B2, and B3 contexts are included, averaging 40 cm in thickness and encompassing 65.48 m^3 of sediment. This unit contains 14 cultural features, 6,251 flakes, 313 chipped stone tools, 59 ground or battered stones, 43 ceramic sherds, 13,512 g of vertebrate faunal remains, 860 mussel shells, and 88 kg of burned rocks. As discussed above, the radiocarbon dates indicate that this component relates to occupations between the early A.D. 1400s and perhaps the early A.D. 1500s, with the most intensive use in the A.D. 1470s. With most of the remains resulting from use over a short time span and associated with the surface of the paleosol in configurations that imply substantial contextual integrity, the potential for spatial analyses to provide meaningful information is high, particularly in light of the good preservation of faunal remains. Having said that, the presence of unburned plant parts (see Appendix F) and the frequent observation of vertical cracks in the lower alluvial unit filled with sand from the upper unit make it clear that some amount of bioturbation has occurred.

Excavated proveniences more than ca. 20 cm above the paleosol surface are assigned to the Upper unit. This is the case in deposits 7–48 cm thick in just 12 data recovery units, with a total volume of 1.75 m^3. This unit contains 14 flakes, 0.1 g of vertebrate faunal remains, 2 mussel shells, and 0.3 kg of burned rocks. There are no data to estimate temporal parameters, and it is most likely that these materials have been displaced upward from the Toyah component by bioturbation. In addition to artifact densities being low, this unit has poor preservation of organic remains and is considered to have no contextual integrity.

Excavated proveniences more than ca. 30 cm below the paleosol surface but above the Late Archaic remains at the bottom of the excavations are assigned to the Lower unit. These deposits were sampled in only six test units, with the volume totaling 1.9 m^3. This unit contains 14 flakes, 2 chipped stone tools, 30.2 g of vertebrate faunal remains, 45 mussel shells, and 4.3 kg of burned rocks. As noted, these sediments may have been deposited in Transitional Archaic or early Late Prehistoric times, but it is unknown whether the cultural materials relate to occupations then or were introduced from above by bioturbation. The latter seems more likely, though. There are no radiocarbon dates to help resolve this question, and with no features, low artifact densities, and poor preservation of organic remains, this unit is considered to have low contextual integrity.

The lowermost 20–30 cm in three test units sampled a Late Archaic component that is the fourth analytical unit. The volume excavated is 0.7 m^3. This unit contains a single cultural feature, 1 Ensor dart point, 20.1 g of vertebrate faunal remains, 65 mussel shells, and 3.4 kg of burned rocks. The dart point is the sole bit of chronological evidence, and thus it is hard to estimate the temporal parameters of the unit. Based on the analysis of radiocarbon dates and point types by Lohse, Black, and Cholak (2014:270–271), it is likely that it dates sometime between 200 B.C. and A.D. 200. The single feature is a small scatter of mussel shells rather than a constructed facility, and thus it does imply much about the integrity of the deposits. Regardless of that, the cultural remains are so sparse that little can be said about this occupation.

Finally, proveniences in seven test units and two excavation units that were distant from the data recovery block are unassigned in terms of analytical unit. These proveniences total 7.86 m^3. In some (Test Units 3–6), it is not clear how the excavation levels relate to the paleosol and the two alluvial units. In others (Test Units 1, 2, and 9 and Excavation Units A and B), this relationship is known. In all cases, however, cultural materials are so sparse (1 cultural feature, 92 flakes,

Table 6.3. Proveniences assigned to analytical units

Unit	Elevation, top (m)	Elevation, bottom (m)	Thickness (m)
Upper			
EU 2	98.97	98.90	0.07
EU 4	98.94	98.80	0.14
EU 9	98.47	98.40	0.07
EU 12	99.10	98.90	0.20
EU 56	98.38	97.90	0.48
EU 59	98.45	98.30	0.15
EU 63	98.20	98.10	0.10
EU 95	98.07	98.00	0.07
EU 101	97.98	97.90	0.08
EU 126	98.47	98.40	0.07
EU 138	98.14	97.90	0.24
EU 139	97.98	97.90	0.08
Toyah			
TU 07	98.49	98.19	0.30
TU 08	98.49	98.19	0.30
TU 10	98.49	98.09	0.40
TU 11	98.49	98.09	0.40
TU 12	98.30	97.90	0.40
TU 13	98.30	97.90	0.40
TU 14	98.03	97.53	0.50
TU 15	98.03	97.43	0.60
TU 16	98.03	97.53	0.50
TU 17	98.03	97.53	0.50
TU 18	98.03	97.53	0.50
TU 19	98.03	97.53	0.50
EU 1	98.82	98.50	0.32
EU 2	98.90	98.40	0.50
EU 3	98.80	98.40	0.40
EU 4	98.80	98.40	0.40
EU 5	98.82	98.40	0.42
EU 6	98.72	98.30	0.42
EU 7	98.61	98.20	0.41
EU 8	98.55	98.10	0.45
EU 9	98.40	98.00	0.40
EU 10	98.33	97.90	0.43
EU 11	98.21	97.90	0.31
EU 12	98.90	98.50	0.40
EU 13	98.87	98.50	0.37
EU 14	98.80	98.50	0.30
EU 15	98.83	98.50	0.33
EU 16	98.70	98.40	0.30
EU 17	98.72	98.30	0.42
EU 18	98.63	98.20	0.43
EU 19	98.55	98.10	0.45
EU 20	98.53	98.00	0.53
EU 21	98.42	97.90	0.52
EU 22	98.30	97.90	0.40
EU 23	98.90	98.50	0.40
EU 24	98.94	98.50	0.44
EU 25	98.35	97.90	0.45
EU 26	98.50	98.00	0.50
EU 27	98.30	97.90	0.40
EU 28	98.44	98.00	0.44
EU 29	98.18	97.80	0.38
EU 30	98.22	97.80	0.42
EU 31	98.20	97.80	0.40
EU 32	98.25	97.80	0.45
EU 33	98.26	97.70	0.56
EU 34	98.25	97.80	0.45
EU 35	98.22	97.80	0.42
EU 36	98.18	97.80	0.38
EU 37	98.30	97.80	0.50
EU 38	98.29	97.90	0.39
EU 39	98.10	97.70	0.40
EU 40	98.06	97.70	0.36
EU 41	98.21	97.80	0.41
EU 42	98.23	97.80	0.43
EU 43	98.07	97.60	0.47
EU 44	98.11	97.70	0.41
EU 45	98.02	97.70	0.32
EU 46	98.00	97.60	0.40
EU 47	98.02	97.60	0.42
EU 48	98.00	97.60	0.40
EU 49	98.24	97.70	0.54
EU 50	98.22	97.80	0.42
EU 51	98.31	97.90	0.41
EU 52	98.36	98.00	0.36
EU 53	98.44	98.00	0.44
EU 54	98.46	98.10	0.36
EU 55	98.19	97.80	0.39
EU 56	98.20	97.90	0.30
EU 57	98.43	98.00	0.43
EU 58	98.33	97.90	0.43
EU 59	98.30	97.90	0.40
EU 60	98.44	98.10	0.34
EU 61	98.49	98.10	0.39
EU 62	98.50	98.20	0.30
EU 63	98.10	97.70	0.40
EU 64	98.07	97.70	0.37
EU 65	98.20	97.70	0.50
EU 66	98.10	97.70	0.40
EU 67	98.10	97.70	0.40
EU 68	98.18	97.60	0.58
EU 69	98.05	97.70	0.35
EU 70	98.20	97.70	0.50
EU 71	98.10	97.70	0.40
EU 72	98.10	97.70	0.40
EU 73	98.16	97.60	0.56
EU 74	98.02	97.70	0.32

Table 6.3, continued

Unit	Elevation, top (m)	Elevation, bottom (m)	Thickness (m)
EU 75	98.10	97.70	0.40
EU 76	98.10	97.60	0.50
EU 77	98.47	98.00	0.47
EU 78	98.52	98.20	0.32
EU 79	98.54	98.20	0.34
EU 80	98.60	98.20	0.40
EU 81	98.42	98.00	0.42
EU 82	98.46	98.00	0.46
EU 83	97.97	97.60	0.37
EU 84	98.06	97.70	0.36
EU 85	98.12	97.70	0.42
EU 86	98.10	97.70	0.40
EU 87	98.02	97.60	0.42
EU 88	98.02	97.60	0.42
EU 89	97.87	97.50	0.37
EU 90	97.86	97.50	0.36
EU 91	97.80	97.40	0.40
EU 92	97.84	97.50	0.34
EU 93	97.86	97.50	0.36
EU 94	97.95	97.60	0.35
EU 95	98.00	97.60	0.40
EU 96	97.84	97.50	0.34
EU 97	97.80	97.50	0.30
EU 98	97.91	97.50	0.41
EU 99	97.85	97.50	0.35
EU 100	97.83	97.50	0.33
EU 101	97.90	97.60	0.30
EU 102	98.01	97.60	0.41
EU 103	98.59	98.20	0.39
EU 104	98.66	98.30	0.36
EU 105	98.71	98.30	0.41
EU 106	98.55	98.10	0.45
EU 107	98.60	98.10	0.50
EU 108	98.80	98.50	0.30
EU 109	98.67	98.50	0.17
EU 110	98.93	98.50	0.43
EU 111	98.70	98.30	0.40
EU 112	98.88	98.50	0.38
EU 113	98.87	98.50	0.37
EU 114	98.95	98.60	0.35
EU 115	98.78	98.40	0.38
EU 116	98.81	98.50	0.31
EU 119	98.90	98.50	0.40
EU 120	98.60	98.10	0.50
EU 123	98.88	98.50	0.38
EU 124	98.23	97.90	0.33
EU 125	98.38	97.90	0.48
EU 126	98.40	98.00	0.40
EU 127	97.95	97.50	0.45
EU 128	98.05	97.70	0.35
EU 129	98.05	97.70	0.35
EU 130	98.21	97.90	0.31
EU 131	98.22	97.90	0.32
EU 132	98.33	98.00	0.33
EU 133	97.90	97.50	0.40
EU 134	97.94	97.60	0.34
EU 135	98.01	97.70	0.31
EU 136	97.92	97.50	0.42
EU 137	98.01	97.60	0.41
EU 138	97.90	97.50	0.40
EU 139	97.90	97.50	0.40
EU 140	98.06	97.60	0.46
EU 141	97.94	97.60	0.34
EU 142	98.61	98.20	0.41
EU 143	98.63	98.30	0.33
EU 144	98.66	98.30	0.36
EU 145	97.80	97.50	0.30
EU 146	97.84	97.50	0.34
EU 147	97.80	97.50	0.30
EU 148	97.99	97.60	0.39
EU 149	98.01	97.60	0.41
EU 150	98.72	98.40	0.32
EU 151	98.68	98.30	0.38
EU 152	98.67	98.30	0.37
EU 153	97.84	97.50	0.34
EU 154	98.66	98.30	0.36
EU 155	98.66	98.40	0.26
EU 156	98.77	98.40	0.37
EU 157	98.84	98.50	0.34
Lower:			
TU 07	98.19	97.99	0.20
TU 08	98.19	97.79	0.40
TU 10	98.09	97.69	0.40
TU 12	97.90	97.80	0.10
TU 13	97.90	97.50	0.40
TU 15	97.43	97.03	0.40
Late Archaic:			
TU 08	97.79	97.49	0.30
TU 10	97.69	97.49	0.20
TU 13	97.50	97.30	0.20
Unassigned			
TU 01	99.12	98.12	1.00
TU 02	99.12	98.12	1.00
TU 03	98.90	97.90	1.00
TU 04	98.90	97.90	1.00
TU 05	99.24	98.24	1.00
TU 06	99.24	98.24	1.00
TU 09	99.12	98.12	1.00
EU A	99.38	98.90	0.48
EU B	99.40	99.02	0.38

3 chipped stone tools, 1 unmodified flake tool, 68.2 g of vertebrate faunal remains, 127 mussel shells, and 13.4 kg of burned rocks) that connecting them to the units defined for the block serves no purpose.

IDENTIFYING THE RANGE OF ACTIVITIES

Feature Construction and Use

Of the 16 cultural features recorded, only 7 are constructed facilities and thus subject to discussion here. The others (Features 3, 5, 7, 11, 12, 13, 15, 17, and 18) are scatters of various kinds of debris (burned rocks, animal bones, mussel shells, and lithic artifacts) that were sufficiently noticeable in the field to receive feature designations or, in the case of Feature 18, were identified after fieldwork. Of these debris scatters, one (Feature 3) was in Trench 9 outside the data recovery block, and one (Feature 7) relates to a Late Archaic occupation. The other 7 are associated with the Toyah phase occupation sampled in the block excavations; they are discussed more in the Spatial Analysis and Identification of Activity Areas section later in this chapter.

Table 6.4 summarizes information on the seven constructed features, all of which had thermal functions. Three (Features 4, 9, and 14) are shallow pits containing ash, very few or no burned rocks, and sparse botanical remains. The limited economic plant remains consist of pecan shells and hawthorn and sedge seeds. Fuel woods recovered are mostly white group oak and elm. Features 9 and 14 clearly originated at the paleosol surface, were 8 cm deep, and had evidence of in situ burning. Feature 4 may have originated at that same surface, in which case it would have been 19 cm deep, but it was found in the bottom of a backhoe trench and may have been truncated by the machine; it lacked clear evidence of in situ burning, perhaps because its upper part was lost. Features 4 and 14 are both small, with maximum diameters of 36 and 22 cm. Feature 9 is larger, measuring 56 cm across, but its full dimensions are unknown, since it was exposed only in the wall of the excavations. With abundant ash and little charcoal, these three features are interpreted as open hearths constructed in shallow pits, consistent with the criteria that Thoms et al. (2015:161) outline. The precise functions of these hearths are unknown. They could have been heat sources or used in cooking food or some other processing activity. In any case, rock heating elements were not part of their construction and use.

The opposite is true for the other four features. Features 6, 8, 10, and 16 all have abundant burned rocks, with densities ranging from 134.7 to 831.4 kg/m^3 (see Table 6.4). They also are shallow pits 10–21 cm deep. Features 8, 10, and 16 originated at the paleosol surface, but Feature 6 was 21 cm below that surface. As discussed above, it probably relates to a Toyah phase occupation earlier than the main one. Features 6, 8, and 16 are roughly the same size, with maximum diameters of 68–80 cm and covering areas of 0.31–0.44 m^2. Feature 8 is more than twice as large; its long dimension is 120 cm, and its area is 0.88 m^2. All four have evidence of in situ burning, lack ash, and have abundant charred plant remains beneath and surrounding the burned rocks. These characteristics suggest that the concentrations of rocks in them could be heating elements in earth ovens (Thoms et al. 2015:161–163), but the shallowness of the pits might argue that they functioned more as open hearths (since the removed pit fill might not have been sufficient to

Table 6.4. Summary of thermal features

						Burned Rocks							Plant Remains	
Feature	Depth (cm)	Size (cm)	Area (m^2)	Ash	In Situ Burning	kg	#	kg/#	kg/m^3	0–5 cm (%)	Broken In Situ?	Form Intact Basin?	g/liter	Identification
4	0–19?	25x36	0.07	yes	?	0.1	3	0.03	1.5?		no	no	0.9	pecan shell, hawthorn seed; wood charcoal mostly white group oak and elm
6	21–35	66x68	0.35	no	yes	6.6	38	0.17	134.7	13	no	no	9.0	hawthorn seed; wood charcoal mostly hickory/ pecan and hackberry
8	0–21	120x93	0.88	no	yes	56.5	425	0.13	305.7	55	yes	yes	23.7	tuber; wood charcoal mostly elm, white group oak, and hawthorn
9	0–8	56x?	0.25?	yes	yes	–	–	–	–		–	–	–	–
10	1–13	72x78	0.44	no	yes	43.9	48	0.91	831.4	8	yes	yes	9.9	acorn; wood charcoal mostly elm and white group oak
14	0–8	22x22	0.04	yes	yes	0.0	0	–	0.0		–	–	0.3	sedge seed; wood charcoal mostly elm
16	0–10	80x50	0.31	no	yes	5.2	25	0.21	167.7	24	no	no	6.8	wood charcoal mostly white group oak and elm

Note: Depths are top and bottom of feature below paleosol surface.

cover an oven). The smaller three are consistent with what Thoms et al. (2015:162) call family-sized ovens; the largest one is in their intermediate size category. None is large enough to be considered a communal feature. Features 8 and 10 have rocks broken in situ and oriented in ways that indicate portions of intact heating elements. Features 4 and 16 lack such evidence, probably because heating elements were disturbed during cleaning episodes.

Feature 10 has the largest rocks and Feature 8 the smallest, as measured by both weight per rock (0.91 vs. 0.13 kg) and the percentage of rocks less than 5 cm in maximum dimension (8 vs. 55 percent). This could indicate more-intensive use of Feature 8 than Feature 10. Features 6 and 16 tend to have moderate-sized rocks. All four have rocks that are larger than the scattered burned rocks found in nonfeature contexts around them, which have an average weight per rock of 0.06 kg. This is consistent with interpretation of these features as heating elements in earth ovens or surface features (Thoms et al. 2015:162) and the associated scatters as exhausted materials removed from them. An alternate explanation for the smaller rocks in the scatters, i.e., that they represent the byproducts of stone boiling (Thoms et al. 2015:163), is not supported by the evidence. Specifically, Thoms et al. (2015:161) note that stone boiling entails tethered facilities, i.e., a "surface fire to heat the rocks and something to contain the water, often just a pit, which lacks evidence of in situ combustion." The excavated portion of the site has no such pits, and information presented in Chapter 5 on the vertebrate faunal remains suggests that intensive bone breakage for grease production was not an important activity at the site. Further, some of the parts of the site with the highest densities of scattered burned rocks are proximate to Features 6, 8, and 16, supporting the idea that the scattered rocks represent materials cleaned out of those ovens or hearths (see Spatial Analysis and Identification of Activity Areas). The absence of such a concentration near Feature 10 is consistent with the interpretation that it was used less intensively than the others (i.e., it may have been used only once or a few times and not cleaned).

Economic plant remains in the oven or hearth features are limited to a hawthorn seed, an acorn nutshell fragment, and an Indian breadroot tuber fragment. The latter probably is most significant, as there is a growing body of evidence that a primary function of earth ovens in central Texas was to process carbohydrate-rich foods such as Indian breadroot (Black, Ellis, et al. 1997; Black and Thoms 2014; Thoms et al. 2015). Fuels used in these features were predominantly hickory/pecan and hackberry wood (Feature 6) and elm and white group oak wood (Features 8, 10, and 16). All of these kinds of trees likely were common on the Leon River floodplain when the site was occupied, and all but hickory/pecan would have grown on the adjoining uplands as well.

Tool Production, Use, Maintenance, and Discard

Table 6.5 summarizes the Toyah phase artifact assemblage. The following sections explore six main topics relating to what the assemblage conveys about the range of activities Toyah peoples performed at the Jayroe site: stone tool assemblage structure; raw material procurement; stages of stone tool manufacture, use, and discard; male and female gender identities and lithic technologies; ceramic technology; and bone tool technology.

Table 6.5. Summary of the Toyah phase component artifact assemblage

Artifact Type	Number (weight)	Percent
Cores:		
Blade	1	4.3
Bifacial or discoid	8	34.8
Tested cobble/pebble	1	4.3
Cobble/pebble	1	4.3
Partial cobble/pebble	2	8.7
Macroflake	1	4.3
Microflake	1	4.3
Noncortical	1	4.3
Fragments	7	30.4
Total	23	100
Debitage:		
Chert, >1.0 inch	39 (968.3 g)	0.6 (14.7)
Chert, 0.75–1.0 inch	160 (1,387.9 g)	2.5 (21.1)
Chert, 0.5–0.75 inch	779 (2,184.4 g)	12.0 (33.2)
Chert, 0.25–0.5 inch	3,286 (1,764.3 g)	50.8 (26.8)
Chert, <0.25 inch	2,197 (258.5 g)	34.0 (3.9)
Orthoquartzite, 0.5–0.75 inch	2 (11.9 g)	<0.1 (0.2)
Orthoquartzite, 0.25–0.5 inch	1 (0.5 g)	<0.1 (<0.1)
Obsidian, <0.25 inch	5 (0.4)	<0.1 (<0.1)
Total	6,469 (6,576.2 g)	100/100
Chipped Stone Tools:		
Flake tools	94	29.8
Convex end scrapers	16	5.1
Other unifaces	20	6.3
Drills, perforators, and gravers	15	4.8
Chopping tool	1	0.3
Bifaces, knife	8	2.5
Bifaces, beveled knife	12	3.8
Bifaces, Stage 1	5	1.6
Bifaces, Stage 2	11	3.5
Bifaces, Stage 3	5	1.6
Bifaces, Stage 4	2	0.6
Bifaces, other	23	7.3
Dart point, Darl	1	0.3
Arrow point, Cuney	1	0.3
Arrow point, Harrell/ Washita	1	0.3
Arrow points, Perdiz	41	13.0
Arrow point preforms, Perdiz	12	3.8
Arrow points, Scallorn	2	0.6
Arrow points, untyped	24	7.6
Arrow point preforms, untyped	21	6.7
Total	315	100
Ground and Battered Stone Tools:		
Hammerstones	8	13.6
Anvil	1	1.7
Slabs	4	6.8
Manos	3	5.1
Polishing stone	1	1.7
Potential pigment stones	38	64.4
Indeterminate	4	6.8
Total	59	100
Ceramic Sherds:	43 (324.5 g)	–
Bone Tools/Modified Bones:		
Awls	4	33.3
Grooved-and-snapped/ sawn	3	25.0
Ornaments/decorated bones	2	16.7
Modified antler tines	2	16.7
Possible rasp	1	8.3
Total	12	100

Stone Tool Assemblage Structure

Considering the tools alone, ground and battered stones represent a small proportion relative to flaked stones, especially given that almost two-thirds of the former are potential pigment stones rather than items used in processing tasks. With the second-largest group being hammerstones, some of which surely were used to make flaked stone tools, it appears that activities requiring ground and battered stones, such as use of manos, anvils, and slabs to process some plant foods, were limited. Also lacking are large anvils and hammerstones indicating much processing of animal bones for grease extraction, consistent with the results of the bone fracture analysis presented in Chapter 5.

Conversely, the abundance of arrow points, knives, and scrapers indicates that hunting and processing the results of the hunt figured prominently in what Toyah peoples did there. The numerous flake tools could relate to processing of butchered animals or any number of other activities. These tools were used in second- or third-stage butchering of selected bison carcass parts returned to the camp, complete butchery and processing of deer/pronghorn-sized mammals, and removal and preparation of deer skins and the bison hides that were returned with the selected carcass parts from kill sites. Unifacial and unmodified flake tools probably were used to process smaller mammals, reptiles, and fish. Flake tools, burins, and drills were likely used in the manufacture of bone tools, with the raw materials coming from splintered pieces of bison and deer/pronghorn metatarsals or other long bone fragments.

The chipped stone tool assemblage represents an amalgam of onsite manufacture, use, and discard of formal tools such as arrow points, bifacial and beveled knives, unifaces, and other flake tools. Cores, biface and arrow point preforms, and manufacturing failures indicate tool production, as do damaged and worn projectile points, knives, and other implements with evidence of maintenance and repair. Patterns of breakage on formal tools and unifaces indicate that some components of individual tool kits were used elsewhere before being brought back to 41HM51 for repair.

Raw Material Procurement

As discussed in Chapter 5, chert is the overwhelming material represented in the chipped stone assemblage, with the vast majority being Edwards chert from primary and secondary geological contexts. Raw material availability in the immediate vicinity of 41HM51 is poor, however, and little chert of suitable size was observed as part of the bed load of the adjacent Leon River. Hence, chert procurement did not occur onsite to any measurable degree, and the bulk of the materials needed to make chipped stone tools had to be brought in, albeit not from great distances (see section entitled "Procurement of Other Resources" later in Chapter 6 for the results of the lithic sourcing study done for this project). In contrast, most of the raw materials used to make ground and battered stone tools—limestone, sandstone, quartzite, and limonite/ocher/hematite—probably were procured more locally.

Toyah peoples brought lithic materials to the Jayroe site in several forms: unfinished bifaces, finished bifaces and projectile points, broken projectile points, and cores. They produced tools from cores and blanks, leaving evidence of all stages of manufacture. They also discarded broken and worn-out tools, and they occasionally recycled them into other expedient tools or converted them to raw material sources. This type of raw material provisioning, which includes aspects of both individual- and activity-level provisioning, is consistent with individuals and groups equipping themselves with personal gear (Binford 1979; Kuhn 1990).

Although cores are not frequent, it appears that core reduction may have been more important than biface reduction in contributing raw materials for tool manufacture. This is based on the prominence of core-derived expedient flake tools, burins, simple unifaces, and convex end unifaces, which together account for 43 percent of the chipped stone tools. Bifaces (minus projectile points) represent 20 percent. There is no indication that any raw materials were stockpiled at the site in finished or partially finished artifact forms.

Stages of Stone Tool Manufacture, Use, and Discard

The Toyah occupants of the site made tools there, used and maintained them, and eventually discarded them, all in support of activities associated with use of the thermal features, procurement and processing of mostly bison and deer, procurement and processing of plant foods, and other subsistence-related tasks. This section uses attributes such as breakage patterns, manufacture/use/discard stage, tool type, and evidence of recycling to address stone tool use and wear broadly defined (as opposed to microscopic analysis of tool edges, which conveys little about these behaviors beyond what tool morphology alone tells us in assemblages such as this one, where there is no evidence that tools were repurposed functionally).

The artifacts indicate that all stages of tool manufacture were performed there, but early reduction is decidedly under-represented. The facts that only 7 percent of the debitage has any exterior cortex and 85 percent is smaller than 0.5 inches supports this conclusion, as does the scarcity of cores and of tools with cortex. Clearly, most early-stage reduction was done elsewhere, presumably near where the raw materials were procured. This argues that the early-stage (Stages 1 and 2) bifaces present at the site may not have been made there, but instead were brought in as preforms as components of personal gear and individual toolkits.

Table 6.6 showing fracture types and cause of discard for the chipped stone tools provides additional evidence for onsite tool manufacture and use. Snap/end shock fractures are most abundant at 36 percent and can be attributed to both manufacture and use. Breaks attributable to manufacture specifically (i.e., perverse, overshot, hinge/step, material flaw, edge collapse, and platform loss) occur on 8 percent and are most common on nonknife bifaces and arrow point preforms; clearly, at least these two tool forms were often made at 41HM51. Use-related breaks (i.e., impact) also occur on 8 percent and are present only on arrow points, reflecting return of arrows damaged in the hunt to the site for replacement in preparation for future hunting forays. The fact that 10 percent of the arrow points, 5 percent of the bifacial knives, and 13 percent of the end scrapers are resharpened is consistent with the idea that a portion of the assemblage represents tools that were maintained in preparation for future needs. Twenty-one tools (7 percent) were discarded because they had reached the end of their use lives, i.e., they were exhausted. This occurred most commonly with end scrapers, 56 percent of which were thrown away because they were used up. This also is the case with most of the battered and ground stone tools (74 percent, excluding potential pigment stones), probably indicating that these were easily replaced situational items rather than parts of portable tool kits.

Table 6.6. Fracture types and causes of discard for selected Toyah component chipped stone tool categories

Fracture Type/Discard Reason	Arrow points	Arrow point preforms	Beveled knives	Bifacial knives	Other bifaces	Drills, perforators, and gravers	End scrapers	Other unifaces	Flake tools	Totals
Exhausted	3		1		4		9	3	1	21
Impact	25									25
Snap/end shock	34	15	8	5	16	12	1	1	23	115
Perverse	1	8			2				1	12
Overshot			1		2					3
Hinge/step					1					1
Material flaw		1			1					2
Edge collapse					2					2
Platform loss					3				1	4
Resharpening								1		1
Thermal					3				1	4
Deliberate radial/snap		1	2	3	2		2	8	20	38
Indeterminate discard reason	6	8			10	3	4	7	47	85
Totals (# broken)	69 (62)	33 (25)	12 (11)	8 (8)	46 (35)	15 (12)	16 (4)	20 (11)	94 (63)	313

The technological organization strategies of the groups at 41HM51 included equipping themselves with transportable tool blanks and preforms to meet anticipated future tool use and task needs. There is more use- and manufacture-related breakage in projectile points and bifaces than unifaces. These artifact categories reflect different contexts of use that resulted in different patterns of tool breakage, maintenance, and discard. While these variations in tool use life histories may be related to patterns of tool use, they also suggest distinct differences in the way individuals furnished themselves with raw materials needed to accomplish different types of tasks at 41HM51 and how different tasks and contexts of use influenced tool longevity.

Thirty-eight tools (13 percent) have deliberate radial or snap breaks (or a combination of these). These types of fractures are most abundant among flake tools, occurring on 21 percent of the total and 32 percent of the broken ones, but they are also present on convex end scrapers, other unifaces, all classes of bifaces, and a single arrow point preform. The distribution of these fractures and their abundance among flake tools may be related to the specific tasks these implements were used to accomplish or how they were curated or recycled by the tool users. Modifying stone tools via bend or radial breaks is an efficient way to extend the utility of raw material masses in areas of scarce suitable tool resource material. It is an effective means of transforming broken or worn tools that otherwise would be discarded. The technique has been documented among mobile groups in resource-poor areas, where discarded tools and cores essentially become site furniture to be reused during later occupations (Amick 2007). In this sense, tool truncation is not curation of the tool per se, but curation of the raw material represented by the tool.

Male and Female Gender Identities and Lithic Technologies

Discussion of gender identities associated with the Jayroe site employs the terms male and female and men and women synonymously, referring to the social construct of male and female as a gender rather than the biologically determined sex of an individual (e.g., Conkey and Spector 1984; Finlay 2013; Geller 2009; Nelson 2006; Voss 2006). Ethnographic and ethnoarcheological studies of hunter-gatherer and collector-forager groups have demonstrated the significance of women's activities and roles in group cohesion, group survival, and risk reduction and have also identified the critical role played by females in technological choices, provisioning, and organization (Hayden 1981; Lee 1979; Lee and Devore 1968; Yellen 1977).

To address the material representation of females in hunter-gatherer sites in prehistory, several assumptions regarding the organization of technology can be made based the ethnographic present. Much of our understanding of Toyah identity has been based on male-centered activities related to hunting, butchering, and warfare, but it is safe to assume that Toyah women participated in daily life in myriad ways, such as processing of animal resources; capture and processing of small mammals, fish, mussels, and turtles; bone marrow extraction; thermal feature construction and use; collection and processing of plant foods and plants for other purposes; preparing hides/skins; cooking; and, at some locations, manufacture of ceramic vessels. While some of these tasks may have been accomplished without the aid of stone tools or with the assistance of facilities and tools of perishable materials, some of them undoubtedly did involve aspects of stone tool technology.

The lithic technology of the Jayroe site is organized to include formal tools, bifaces, and hunting weaponry associated with a structured process of core reduction and flake production and a more-flexible, generalized pattern of core reduction associated with manufacture of flake tools and unifaces (see Cobb and Webb 1994; Johnson 1986; Teltser 1991). Technological complexity in core reduction and tool design is often linked with hunter-gatherer mobility decisions and assessments of risk avoidance (Carr 1995; Kuhn 1992, 1994; Torrence 1983, 1989a, 1989b; Ugan et al. 2003). Contexts of tool use and discard also appear to support such inferences.

Torrence (1983, 1989a, 1989b) makes a simplified argument of technological complexity (maintainable versus reliable) based on the hypothetical severity of risk a group would face; increased risk equals increased complexity.

With the exception of perhaps kill locations or raw material procurement sites, most Toyah assemblages, including that from 41HM51, represent a mix of these technological choices. Sassaman (1992:254) links aspects of risk and technological complexity with predictions about the types of subsistence activities men and women perform, providing an excellent theoretical bridge to begin to assess the relationships between risk, activities, and tool design associated with gender-specific technology. Gero (1991:180), citing previous research, argues that considerations of lithic raw material types, degree of preparation of tool types, and behavioral/spatial contexts of tool manufacture and use can be used to address gender differences and similarities associated with the technology.

Projectile points likely were manufactured and used by males, whereas hafted end scrapers likely can be interpreted as female-specific implements that constituted a part of their personal tool kits (Bird 1993; Finlay 2013; Sassaman 1992). Other tool classes may have been made and used by both males and females, although perhaps not equally. Further, hunting and gathering likely were conducted simultaneously via a sexual division of labor, as represented by an assemblage that contains a technological mix of formal and expedient technologies (see Sassaman 1992:254), with the former associated more with males and the latter more with females (and perhaps older children regardless of gender). These gender dichotomies are based on ethnographic and ethnoarcheological observations and support the conclusion that both men and women who occupied 41HM51 procured raw materials and manufactured and used tools for their specific tasks (Arthur 2010; Bird 1993; Frink and Weedman 2006; Hayden 1981).

With almost one-third (32 percent) of the chipped stone tools from 41HM51 being arrow points and preforms, male-related activities certainly are well represented. Convex end scrapers, which may have been used mostly by females, are much less frequent at 5 percent, but women's activities may be relatively heavily represented in the 29 percent of the assemblage classed as flake tools. Further, it is possible that most of the 59 ground and battered stones reflect women's activities.

Ceramic Technology

The Toyah component yielded 43 sherds representing a minimum of three vessels. It is possible that all of the sherds are from just these three pots, but the spatial analysis presented later in this chapter indicates the actual number of vessels could be higher (perhaps eight). These vessels appear to be at least two medium-sized to large jars and a small jar or olla. The medium to large jars have burned incrustations on their surfaces that probably represent food residues and thus are cooking vessels. The small jar or olla lacks incrustations and may have been used in a different fashion (e.g., storage), or perhaps whatever was heated or cooked in it did not leave a residue. All of the vessels are Caddo-made pots from east Texas. There is no indication that the Toyah peoples who lived at the Jayroe site were themselves potters, or that they used ceramic vessels made by other Toyah groups. In sum, the occupants of 41HM51 used pots to cook food and perhaps to store food or drink, but they did not manufacture pots, at least not at this location. The lack of any ceramic technology and the fact that sherds are infrequent here compared to some other Toyah sites (see Chapter 7) indicate that ceramic vessels were not a critical part of the material culture of these people. Apparently, they filled most of their needs for containers using other, perishable materials such as baskets and hide bags.

Bone Tool Technology

The Toyah component yielded a small assemblage of bone artifacts consisting of four medial awl fragments, one bison-sized piece of cut bone, two grooved-and-snapped pieces, a possible modified canine tooth, a small piece of burned/polished bone with an incised design, two antler tine fragment with chop marks, and a notched bone. The artifacts are too small and too fragmentary to be very informative about activities performed there, although the antler tines could have been used in flint knapping, and the awls may have been used in processing bison and deer hides or making/repairing basketry or other woven artifacts. The canine tooth and incised bone likely are personal items. The notched bone could be a musical rasp.

Summary

The artifacts and ecofacts indicate that a diverse array of activities associated with the procurement, processing, and consumption of animal, plant, and other resources were performed at the Jayroe site. The technological needs of these activities appear to have been provisioned at an individual level, and based on task diversity, tool assemblage diversity, and feature types, the groups who used the site included both males and females. Hence, it appears the site functioned as a general-purpose campsite rather than a gender-specifc procurement or processing locality.

Food Acquisition and Processing and Nutrition

Acquisition and Processing

The recovered faunal and floral assemblages (see Chapter 5 and Appendixes A and F) and the results of the organic residue analysis on stone tools and ceramics (Appendix H) indicate that the site inhabitants captured or collected and processed an array of faunal and floral resources reflecting a generalized subsistence strategy. Bison and deer were the main animals hunted, with fish, turtles, rabbits, birds, canids, carnivores, pronghorn, raccoon, and squirrel represented in decreasing order (by number, not dietary importance) as well (Table 6.7). Clearly, large mammal hunting was an important part of the subsistence strategy. Most of these animals likely were obtained locally, either from the Leon River, adjacent floodplain around the site, or the surrounding uplands. As discussed below, bison is the sole exception, with element representation suggesting these animals were killed and butchered away from the site.

Also procured locally but in minor amounts were mussels. With just 378 shells in contexts assigned to the Toyah component, it is clear that this was not a

Table 6.7. Vertebrate faunal remains in the Toyah phase analytical unit

Taxon	No.	Wt. (g)
Large Mammals:		
Bison	197	5,560.5
Bison size	527	4,297.3
Deer	532	698.0
Deer size	884	1,415.0
Pronghorn	2	5.3
Subtotal	2,142	11,976.1
Other Mammals:		
Canid	3	1.2
Carnivore	6	6.1
Carnivore size	1	0.1
Dog/coyote	3	10.4
Dog/coyote size	1	0.5
Dog size	1	5.2
Cottontail	1	0.2
Jackrabbit	5	1.8
Rabbit size	74	32.5
Gray squirrel	2	0.8
Raccoon	3	10.1
Raccoon size	1	1.4
Rodent	11	2.1
Rodent size	8	1.6
Subtotal	120	74.0
Other:		
Turkey size	1	4.7
Bird	12	10.0
Bird size	10	1.4
Cooter	5	4.4
Turtle	82	41.4
Catfish	31	24.4
Fish	119	62.6
Snake	8	0.8
Subtotal	268	149.7
Indeterminate:	5,025	2,051.6
Total	7,555	14,251.4

major food source. Mussels are a low-value foodstuff, and their paucity here leads one to question why they were exploited at all (Mehalchick and Kibler 2008:350–351). Diet-breadth models suggest that lower-ranked foods such as mussels will become part of the diet as higher-ranked resources become scarce, but there is nothing to suggest that high-ranked resources such as bison and deer were ever scarce in the site vicinity. A likely interpretation is that their nearby occurrence, ready availability, and low cost of procurement made them an attractive, if occasional, resource to augment the diet, regardless of how diet-breadth models rank them (i.e., this may be an example where optimal foraging theory does not work very well). Both features containing mussel shells likely represent discrete events of procurement and discard, but they would have only met a very small portion of a family's daily dietary requirement. Perhaps another reason they were used is that, while mussels are poor sources of caloric energy, they can provide certain micronutrients that cannot be obtained from terrestrial sources (Popejoy et al. 2015:280). Women and children were the most likely individuals to have collected freshwater mussels from the Leon River (see Popejoy et al. 2015:283).

Quigg (see Appendix A) identified an MNI of approximately five bison. This includes at least two mature males represented by two left distal metatarsals, two females represented by two right radii, and a newborn identified by a single metapodial. Fetal bison fragments indicate that at least one of the female individuals was pregnant. Skeletal element representation for adult/mature animals is limited primarily to appendicular elements of front and back legs and ribs. This pattern is characteristic of kill and butchery at some location away from the site and return of selected portions back to the main camp for further processing. Bulky parts with little meat such as crania, mandibles, and pelvises were likely left at the kill site.

The presence of the newborn and fetal skeletal elements suggests that at least some of the bison hunting was done in late Spring, and element representation for these individuals indicates that younger individuals were returned to camp as complete packages.

Cut marks, chop marks, and some smashed joint areas were identified on adult and probable adult bison bones, correlating with the selection of appendicular portions for return to camp. The basic pattern of dismemberment involved disarticulation at the major joints of the shoulder/scapula and the pelvis/femur. Additional disarticulation involved cutting, chopping, and manual breakage of the vertebral (proximal) ends of ribs away from the spinal column, perhaps during the removal of the meat of the backstrap and ribs which were then returned to camp. At 41HM51, the occupants further processed selected portions by separating additional limb joints and fragmenting long bones and other elements with medullary cavities to remove bone marrow. The presence of impact scars, spiral fractures, and rebound stress features implies the use of stone anvils and hammerstones for this purpose, although as discussed elsewhere, these kinds of tools are conspicuously scarce in the assemblage. Bone splinters with spiral or helical fractures were produced during bone marrow extraction. The fracture freshness index and fragmentation study in Chapter 5 supports an interpretation that bone marrow extraction was more common than bone grease rendering, and, as noted above, the burned rocks at the site appear to represent use of hearths and ovens rather than stone boiling.

Quigg (see Appendix A) identified an MNI of three deer and similar sized animals. At least one skull with attached antlers indicates the presence of one male and suggests procurement in late Winter. Teeth suggest at least three individuals. Some teeth and skeletal elements also correspond with young individuals, one likely 10–15 months old, and one older male. Given the presence of at least one young deer, a late Spring season of procurement is possible. A single molar and a third phalange are the only evidence indicating the presence of a single pronghorn antelope. Element and skeletal part representation of deer indicates that complete individuals were returned to 41HM51 for processing. Butchering and processing for bone marrow is indicated by the presence of impact fractures, spiral fractures, cut marks, and chop marks, with cut marks distributed on ribs, long bones, and joints of front and rear legs. The concentration of burned fragments among ribs may be related to cooking of carcass parts. As with bison, the fracture freshness and fragmentation study indicates that deer elements were selected for their potential to be sources of bone marrow as opposed to bone grease. Fresh breaks are much more common on deer/pronghorn bones than bison bones, however, and deer were processed more extensively or in a different way than bison. Perhaps deer bones had to be broken up more to retreive the marrow because they are smaller than bison bones. Or maybe most of the remains of these two taxa were deposited during separate occupations that differed in terms of seasonality or duration.

Although bison and deer/pronghorn constitute the bulk of procured animal protein at the Jayroe site, a number of smaller mammals, birds, reptiles invertebrates, and fish did contribute to the diet as well. Unlike bison and deer/pronghorn, the skeletal remains of these smaller organisms are not tied to specific concentrations of discarded remains. Individually, any one of these groups would have made only a small contribution to overall individual and group caloric needs, but together they represent a varied and more-generalized diet. Similar dietary composition has been documented at other Toyah phase sites, with the occupants supplementing their diets with additional smaller game resources with lower procurement and processing costs. Rabbits appear to have been of some minor importance to the diet, and the long bones of rabbits and hares commonly exhibit cut marks and spiral fractures indicating that they were broken for marrow. Turtles appear to have contributed in small measure to the diet, but the predominance of carapace/plastron fragments may indicate that the shells were used as containers or vessels after the animals were processed for their meat, as there is no indication that the shells were smashed. Like mussels, fish obtained from the Leon River served as a minor supplemental food resource.

Plant food sources are decidedly under-represented compared to faunal remains, consisting of just 45 pecan nutshells, 1 acorn shell, 2 hawthorn seeds, and a fragment of an Indian breadroot tuber; all of these likely were obtained on or near the site. The assemblage is too small to convey much information about seasonality, but hardwood nuts often are interpreted as indications of occupation during the Fall months (absent the possibility of long-term storage, particularly of pecans), and breadroot is most visible for harvest during the Summer flowering season. Certainly, hardwood nuts, hawthorn fruits, and tubers were not the only plant foods that the Toyah occupants of the site consumed, however. The depauperate nature of this assemblage, both in quantity and variety, reflects at least partly poor preservation of plant remains, not avoidance of plant foods.

Acorns need to be leached to remove the tannins and render them edible. Techniques to remove tannins include prolonged soaking or continuous boiling of fragmented nuts or nut flour and would require combinations of simple ground stone tools (anvils, hammers, manos, metates, and slabs) and lined pits or ceramic containers. The small size of the ground stone assemblage from the site and the absence of pit features suggest that acorn processing was not a prominent activity, although it is possible that the sherds found are from ceramic vessels used in this task. Pecans only require shelling, but, as with acorns, the ground stone assemblage implies that this was not an important activity. Indian breadroot does not require baking or other processing and is edible without further preparation, although it can be baked and prepared in a number of ways. The features interpreted as possible shallow earth ovens could have been used for this purpose.

As reported in Appendix H, seven ceramic sherds, five ground or battered stones, and nine chipped stone tools were submitted for analysis of organic residues they might contain. Residues obtained from all of the sherds and ground/battered stones were analyzed using Fourier transform infrared spectroscopy (FTIR), and proteins recovered from two of the chipped stones were analyzed using counter immunoelectrophoresis. The main conclusions are as follows: (1) six of the sherds have residues that are likely to be from bison bone marrow; (2) one sherd has residue probably representing fuel wood or some carbohydrate-rich plant; (3) all five ground stones have residues, perhaps mostly reflecting use in processing meat, but they are not identifiable to specific animals or plants; (4) a chopper/chopping tool was used to process rabbit and perhaps bison; (5) a biface was used to process rabbit and perhaps American eel; and (6) the other seven chipped stone tools do not have protein residues.

Other than the possible addition of American eel to the list of resources used at the site, these data are not very enlightening. A third of the samples contained no residues, and 29 percent yielded residues that could not be identified specifically. Bison, or possible bison, is best represented on the remainder, followed by rabbit. The range of other animals known to have been used based on the faunal remains recovered (see Table 6.7) is not indicated in the residues. Most interesting is the suggestion that most of the sherds are from vessels in which bison bone marrow may have been processed at some point in their use histories, which is consistent with the abundance of bison bones that appear to have been broken to retrieve marrow.

Two common problems with interpreting residue data, having good baseline comparative information and diagenetic changes in archeological residues over time, apply to this assemblage as well as others and limit the conclusions that can be drawn, however. Instructive in this regard are the following statements offered by the author of Appendix H (Linda Scott Cummings, personal communication 2018) in an email discussing the results of this study:

"Some of the assumptions about baseline data are not yet scientific fact. First, there are no baseline data that provide conclusive markers to distinguish bison bone marrow from other types of bone marrow or from fat recovered in other parts of the bison or other land animals. Given diagenesis in archaeological materials, that may never be possible. There is no way to distinguish between land animal fat that comes from bone marrow and fat that comes from other parts of the same animal. We also cannot distinguish between bison and deer or other large animal fat or marrow…. The markers are too similar and considering diagenesis, that's not a good level of interpretation to assume. What we can say is that we have a reference sample of bison fat that comes from bison marrow. It has certain properties, represented by specific FTIR peaks that we also observe in some of your samples. Therefore, if there is other evidence of bison bone marrow processing at the site, it is a logical interpretation that the FTIR record represents the same. In the absence of other visible evidence of bison marrow processing, the FTIR record is not sufficiently robust to indicate this activity. This is because it is not possible to identify bison marrow with any specificity using FTIR…and not using protein residue analysis. In short, the "smoking gun" to indicate bison bone marrow processing is recovery of bison long bones appropriately split or broken. What surprised me was the similarity in the fats/lipids signatures of several sherds and their match with large animal fat/marrow. Our analysis indicates that fatty animal tissue (bones with marrow or fatty meat) were cooked or processed in some of the vessels. The fat is from a land animal (not a fish). I cannot rule out rabbit, but neither can I say with certainty that it should be included in this signature."

The results of the organic residues study have no definitive implications for one the debates dealt with in this report, i.e., the relative importance of marrow extraction vs. bone grease rendering. The presence of likely bison bone marrow residues on the ceramic sherds certainly points to utilization of this resource, but the data are not informative about how the residues got there. One possibility is that they represent addition of marrow scooped from broken bison long bones to stews cooked in the pots. Another is that they are the result of boiling broken-up bison bones to render grease.

Nutrition

This section presents nutritional information for animal and plant resources that were significant components of the prehistoric diet, although such data are not equally available for every resource utilized by Toyah phase hunter-gatherers. Lohse (2015) presents an excellent discussion of nutritional needs and the difficulties of using the available data for assessing prehistoric diets, and that discussion is not reiterated here. Suffice it to say that the issue is a complex one given that nutritional content within a single resource varies depending on many factors that cannot be controlled for in an archeological situation, and the data on content come from modern sources (sometimes food-industry analyses) that may or may not be good analogs for animals and plants consumed prehistorically. Hence, when specific numbers are referenced below, they should be taken with a grain of salt; they are good indicators of the relative nutritional value of various foods, though.

Cordain et al. (2000:618, Table 2) provide economic subsistence dependence information for 63 hunter-gatherer societies worldwide, categorized by living environment, based on ethnographic data, with dependence based on estimated percent of energy intake (for their methods of calculating this, see Cordain et al. 2000:683–684). For the 11 groups in temperate grassland environments, the estimated dependence on gathered resources was 26–35 percent, on hunted resources was 56–65 percent, and on fished resources was 6–15 percent. Table 6.8 presents a hypothesized average daily nutritional intake for prehistoric humans based on a 3,000-calore diet composed of 35 percent meat and 65 percent gathered plant resources (Eaton and Konner 1985:286, Table 3), and Table 6.9 lists some of the resources that the occupants of the Jayroe site consumed or were likely to have consumed, with beef brain as a proxy for bison brain (data are from Helbig [2006], Parmalee and Klippel [1974], and U.S. Department of Agriculture, Agricultural Research Service [2013]). As noted above, plant foods are under-represented on this list because they were poorly preserved compared to animal bones. For that and other reasons, Table 6.9 should be viewed as a very incomplete list. Nonetheless, it shows that all three sources of nutritional energy—protein, lipids (fat and oils), and carbohydrates—are well represented and that many of the resources would have been good sources of caloric energy. All of the vertebrate animal taxa are high in protein, which is critical in formation of body tissue and metabolic processes. Bison and deer meat, bison organ meat, and especially hardwood nuts were good sources of lipids, which are easily stored in

Table 6.8. Proposed nutritional requirements for prehistoric hunter-gatherers

Nutrient	Intake (g)
Protein, animal	190.7
Protein, vegetable	60.4
Fat, animal	29.7
Fat, vegetable	41.6
Carbohydrate	333.6
Fiber	45.7

the body and are available for conversion to energy long after consumption. Primary sources of carbohydrates, which provide quick energy, likely included hardwood nuts and geophytes like prairie turnip. Nuts also were sources of monounsaturated fats and essential fatty acids, which are important for neurological development early in life and provide fat-soluble vitamins (A, D, K, and E) that the human body cannot produce. Various resources contributed other vitamins and minerals, including many not shown on Table 6.9.

Bison and other ungulates, which certainly figured prominently in the diet of the people who occupied the Jayroe site and have dominated interpretations of the diets of hunter-gatherers on the North American Plains for the last 10,000 years, are very lean animals. Over two decades ago, Speth and Spielmann (1983) discussed protein metabolism among hunter-gatherers and the nutritional dangers of subsistence regimes consisting of too much protein and not enough fat. More recently, these findings have been reiterated in the context of Paleoindian communal bison hunting by Speth (2010), who notes that total proportion of body fat in bison can vary from 10 percent in the best of times to only 3 percent in seasonal stress or during certain points in the reproductive cycle. A diet high in such lean meat would have posed a problem for people at 41HM51, unless they were able to access other sources of fat (Speth and Spielmann 1983:3, 5–15). Adequate intake of the correct fats is necessary for calcium absorption and as a source of fat-soluble vitamins (Speth and Spielmann 1983:17–18), and suitable levels of fat are necessary for maintaining the body's energy needs. Otherwise, the body metabolizes protein reserves in skeletal muscle and other stores. As noted above, it appears that the occupants of the Jayroe site avoided this problem in part by eating hardwood nuts. In addition, consumption of bone marrow would have contributed fats, and the analysis of the faunal remains in Chapter 5 notes evidence of this.

Procurement of Other Resources

This section addresses procurement of resources such as firewood, sandstone, and chert for manufacturing tools and use in cooking and heating features. Of these three, locations where suitable materials for making chipped stone tools are most distant from the site, but, as discussed elsewhere in this chapter, the occupants used technological options of prestaged shaping and thinning of cores and biface blanks to solve this problem. Wood for fires of various purposes was abundant locally, as were rocks suitable for use in thermal features and for manufacture of ground and battered stone implements.

Firewood

Laying in a sufficient supply of firewood would have been a daily task at the Jayroe site. Firewood would have been needed for cooking, warmth, and light. Other uses may have included providing heat to aid in drying and curing meats; in leaching and parching acorns, pecans, and seeds; in pretreating bison and deer long bones to loosen the periosteum before smashing them to retrieve marrow; in rendering bone grease; and in treating some raw materials for chipped stone tools. Smoke from fires may have been employed as an insect and pest repellant, although

Table 6.9. Nutritional data for some of the animals and plants consumed at the Jayroe site (values are per 100–g serving)

Constituent	Bison, grass-fed, cooked	Bison liver, raw	Bison heart, raw	Bison tongue, raw	Beef brain, raw	Deer, ground, cooked/broiled	Deer, dried	Antelope, cooked (roasted)	Wild rabbit, cooked, stewed	Catfish, wild, cooked,(dry heat)	*Proptera alataa*	*Actinonaias carinata*	Prairie turnip, raw	Prairie turnip, boiled	Pecans, raw	Acorns, raw	Acorns, dried
Proximates																	
Water (g)	65.09	68.51	69.31	60.11	76.29	64.23		65.9	61.37	77.67	76.5	82.2	60.69	67.68	3.52	27.9	5.06
Energy (kcal)	179	140.85	178.93	255.88	143	187	204.5	150	173	105	77	58	156	129	691	387	509
Protein (g)	25.45	20.68	17.43	16.87	10.86	26.45	19.7	29.45	33.02	18.47	9.5	7.8	2.62	1.64	9.17	6.15	8.1
Total lipid (fat, g)	8.62	4.17	12.09	20.13	10.3	8.22		2.67	3.51	2.85	0.8	0.7	0.36	0.32	71.97	23.86	31.41
Carbohydrate, by difference (g)	0	5.13	0	2.04	1.05	0		0	0	0	7.8	4.5	35.67	29.99	13.86	40.75	53.66
Minerals																	
Calcium (mg)	14	5.57	6.59	5.27	43	14		4	18	11	370	320	130	103	70	41	54
Iron (mg)	3.19	7.17	4.98	3	2.55	3.35	2.5	4.2	4.85	0.35	12.5	12.2	1.27	0.95	2.53	0.79	1.04
Magnesium(mg)	23	21.01	22.9	17	13	24		28	31	28	–	–	63	49	121	62	82
Phosphorous (mg)	213	372.76	217.86	138.57	362	228	144.3	210	2.4	304	812	520	31	20	277	79	103
Potassium (mg)	353	330.1	295.21	255.51	274	364		372	343	419	41	26	156	108	410	539	709
Sodium (mg)	76	68.86	86.23	76.37	126	78		54	45	50	23	7	5	4	0	0	0
Zinc (mg)	5.34	4.38	1.66	2.67	1.02	5.2		1.68		0.61	–	–	0.37	0.28	4.53	0.51	0.67
Vitamins																	
Vitamin C	0	8.1	–	–	10.7	0		0	0	0.8	–	–	5.5	2	1.1	0	0
Thiamin (mg)	0.139	–	–	–	0.092	0.503	0.11	0.26	0.02	0.227	0	0	0.178	0.126	0.66	0.112	0.149
Riboflavin (mg)	0.264	–	–	–	0.199	0.33	0.25	0.73	0.07	0.067	0.3	0.3	0.09	0.039	0.13	0.118	0.154
Niacin (mg)	5.966	–	–	–	3.55	9.257	5.12	–	6.4	2.385	2	0.9	1.071	0.708	1.167	1.827	2.406
Vitamin B-6 (mg)	0.401	–	–		0.226	0.468		–		0.106	–	–	0.47	0.379	0.21	0.528	0.695
Vitamin A (IU)	0	2,466.55	18.35	5.35	7	0	83	0	0	15	–	–	–	–	56	39	0 (IU, RAE)
Lipids																	
Fatty acids, total saturated (g)	3.489	2.51	6.94	11.66	2.3	3.993		0.97	1.05	0.744	–	–	–	–	6.18	3.102	4.084
Fatty acids, total monounsaturated (g)	3.293	1.67	3.41	14.83	1.89	1.939		0.63	0.95	1.099	–	–	–	–	40.801	15.109	19.896
Fatty acids, total polyunsaturated (g)	0.402	0.59	0.56	0.42	1.59	0.444		0.58	0.68	0.636	–	–	–	–	21.614	4.596	6.052

there are known instances of ground-dwelling paper wasps, parasitic wasps, and hornets actually being drawn to smoke. Experimental and ethnohistoric research has emphasized the large volumes of firewood necessary to process and prepare such resources as geophytes, mussels, acorns, bison, and deer, especially for bone grease rendering (Dering 1999; Mauldin and Nickels 2003; Milburn et al. 2009; Sullivan et al. 2001; Thoms 1989, 2008, 2009).

The wood species recovered from the site include a mix of types used primarily for fuel as well as some that have important uses as foods (see Appendix F). Oak (white group) is most abundant, followed by elm/cedar elm, hickory/pecan, mulberry, hackberry, hawthorn, ash, blackhaw, dogwood, and soapberry. With the exception of blackhaw, all are common floodplain community trees, with oak, elm, and hackberry also occurring in upland settings. The Jayroe site inhabitants likely selected wood that was most common and available in the immediate site vicinity, probably focusing on cleaner-burning dead wood; this is supported by the absence of heavy chopping tools in the lithic assemblage. Pecan, oak, and elm are all known to be self pruning (Schaffner and Tyler 1901). These species are shade intolerant and require adequate sunshine to maintain photosynthesis. Otherwise, the tree naturally sheds inner limbs that are not getting enough sunlight. This would have provided an ample supply of dead and seasoned wood as a locally available resource. On some occasions, fruit and mast harvests probably coincided with gathering of firewood.

In their analysis of four sites in the North Bosque River valley, Mehalchick and Kibler (2008:351–352) suggest that the supplies of locally available firewood may have become depleted during some occupations based on the abundance of possumhaw/yaupon charcoal, and they relate this to relatively lengthy use episodes. At the Jayroe site, mulberry, hawthorn, blackhaw, and dogwood charcoal indicates use of similar shrubby trees, but the charcoal is not abundant enough to suggest depletion of firewood. This does not necessarily mean that the 41HM51 occupations especially were short lived, though. Rather, it just seems that dead oak, elm/cedar elm, and hickory/pecan wood was abundant on and near the site.

Of course, not all fires serve the same purpose, and not all firewood is equal. Woods differ in thermal and mechanical properties, combustion speeds, and the amount and smell of the smoke (Bishop et al. 2015:63). The intended purpose of the fire and the selection of appropriate fuels initiate a compromise of matching these properties to the available fuel woods or the decision to incur costs to acquire specific fuels from elsewhere. In the case of the Jayroe site, the latter seems not to have been an issue, but there is some evidence for selection of specific fuels for certain purposes. Specifically, in three of the four shallow earth ovens/surface hearths (Features 8, 10, and 16), most of the charcoal is elm or oak, with hawthorn also being relatively abundant in Feature 8. In the fourth, Feature 6, hickory/pecan and hackberry are most common. Why elm and oak wood was selected in most instances is unknown.

Limestone and Sandstone

In addition to fuel woods, sufficient source material for cooking hearths, cooking pits, and warming fires would have been important. Unlike firewood, which can be relatively easily gathered, bundled, and carried some distance, siting a habitation adjacent to cook stone sources is imperative, if hot-rock cooking will be performed there, as it was at 41HM51. Situated on the Leon River, the site is immediately adjacent to sources of limestone like that found in the features at 41HM51 as part of the bedload of the river channel and as bedrock exposures within and adjacent to the channel. Quaternary alluvium and caliche/gravel exposures are also nearby and would have been secondary sources for limestone, sandstone, and occasional small pieces of chert. Upland and isolated channel exposures of Cretaceous formations (Glen Rose, Paluxy, and Walnut) provided sources of sandstone, limestone, claystone, and occasional occurrences of ferrous minerals (ocher, hematite, and limonite) (Bureau of Economic Geology 1976). Chert is not a component of these formations. While limestone was procured very locally, primary sources of sandstone were a bit farther away, with the Paluxy and Glen Rose formations mapped within a kilometer of the site.

Chert

As discussed in Chapter 5, the vast majority of the chipped stone artifacts are of Edwards chert (identifications based on UV fluorescence colors), and very small numbers are of other materials. Figure 6.5 shows that small outcrops of Edwards Limestone occur at the southwest margin of the Leon River basin, but more-extensive outcrops are present closer to 41HM51, about 25 km to the south, between Cowhouse Creek and the Lampasas River. The latter, and secondary deposits along Cowhouse Creek, are likely source areas for most of the chert materials represented by the chipped stone artifacts (all but one tool and nine flakes), although these materials occur widely and could have been obtained elsewhere in central Texas too. A single chopping tool and two flakes (0.3 percent of the chipped stone tools and <0.1 percent of the debitage) are of Pennsylvanian-age materials probably derived from the Ranger and Winchell Limestones, which crop out 70–75 km west and northwest of the site. The limited use of these cherts probably is due not only to their greater distance, but also to their brittleness and poor conchoidal fracture properties. None of the tools and just three flakes (<0.1 percent) are of quartzite that could have come from the Twin Mountains Formation, which crops out over an extensive area of the Leon River basin just upstream from the site. The unsuitability of these materials for tool use likely relates to both their small size and sporadic and unpredictable occurrence.

As part of the 41HM51 project, a selective survey of specific geological outcrops and Holocene terraces and stream channel gravel bars across the northern part of the Leon River basin and adjacent areas was completed to examine the distribution of cherts and identify potential raw material source areas. Prewitt and Associates archeologists Karl Kibler and John Dockall visited 23 locations (out of 41 potential ones identified before fieldwork) consisting of the following: 1 outcrop of Twin Mountains Formation (Ktm) capped by a Pleistocene gravel terrace; 13 locations of Quaternary alluvium along the Sabana River, Leon River, and Cowhouse Creek; 7 primary outcrops of Edwards Limestone (Ked); 1 primary outcrop of Ranger Limestone; and 1 primary outcrop of the Thrifty and Graham

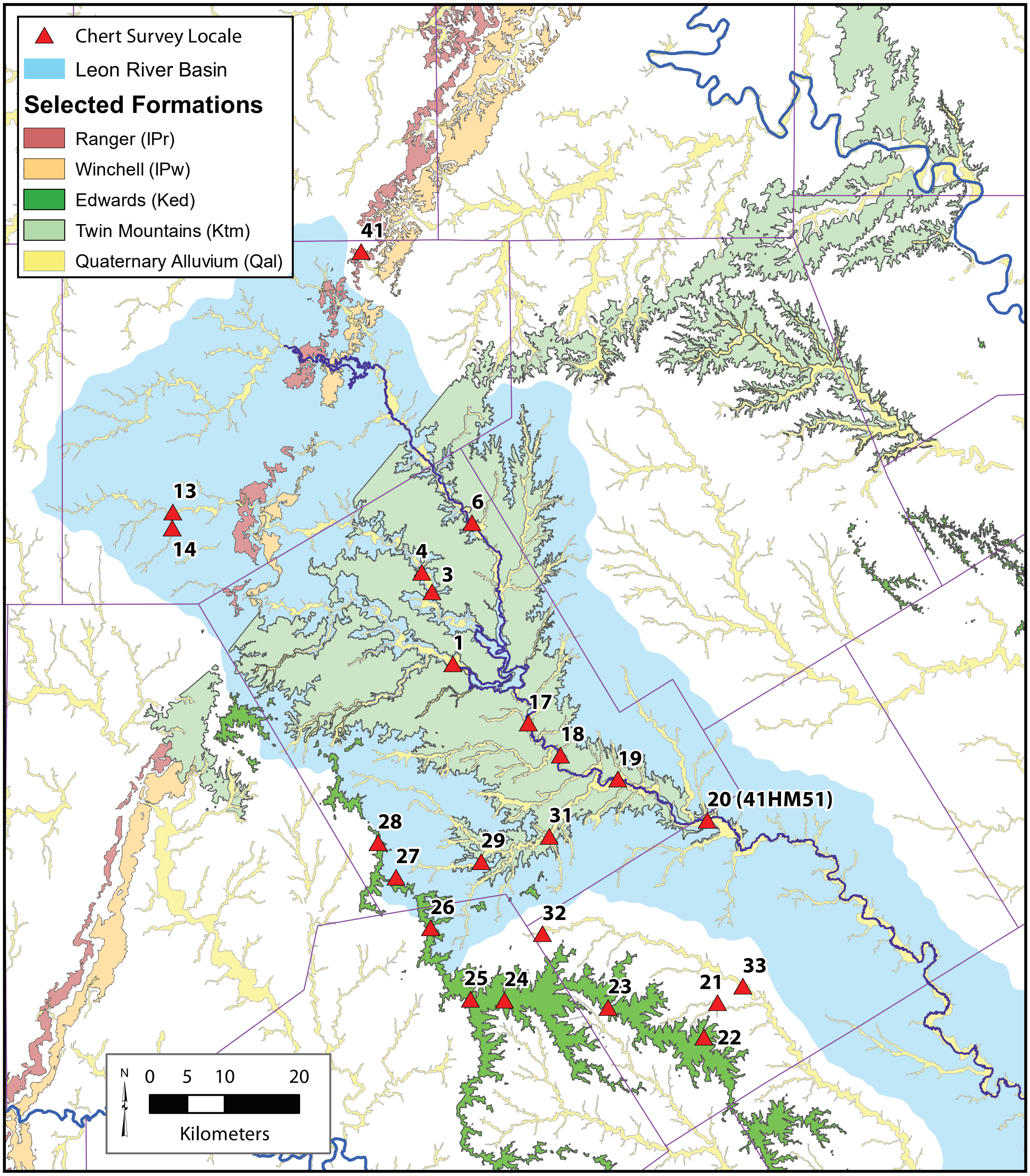


Figure 6.5. Principal chert-bearing Pennsylvanian and Cretaceous formations in the vicinity of 41HM51 and mapped Quaternary alluviums. Numbered triangles are localities visited during survey for potential lithic raw material sources.

Formations (a Pennsylvanian mudstone, sandstone, and limestone that sometimes contains chert pebbles). Table 6.10 summarizes the results of that survey.

Cherts of a size and quality suitable for tool manufacture were observed at the Twin Mountains/Pleistocene terrace location, 6 of the 7 Edwards Limestone primary outcrops, and 5 of the 13 Quaternary alluvium localities; all of the latter were situated such that they receive secondary materials from Edwards Limestone exposures. The Edwards cherts observed at these locations were various overlapping shades of gray, grayish brown, yellowish gray, yellowish brown, and cream, colors that closely match those in the chipped stone assemblage from the Jayroe site. The 8 Quaternary alluvium localities where useable cherts were absent receive secondary material from Pennsylvanian-age formations and formations that do not have chert as a constituent. None of the Quaternary alluvium sources contained cherts that could be identified as coming from either Ranger or Winchell Limestone; this suggests that the few artifacts of these materials at 41HM51 were obtained from primary rather secondary outcrops. The single primary Ranger outcrop contained chert, but it would be of limited utility for tool manufacture because of poor fracture properties.

Initially reduced percussion cores, thick bifaces, and cortical debris were observed at some of the Edwards Limestone exposures. These kinds of artifacts are rare in the Jayroe site assemblage, supporting the conclusion that the occupants of the site incorporated visits to these and other distant chert sources to obtain prestaged lithic material. Also associated with this were formal artifact curation and behaviors like tool truncation and artifact resharpening.

SPATIAL ANALYSIS AND IDENTIFICATION OF ACTIVITY AREAS

The brief span of time over which most of the Toyah phase occupation occurred provides an unusual opportunity to examine the spatial distributions of features, artifacts, and ecofacts with an eye toward defining activity areas and determining how the occupants structured their camp site. This section does that, after opening with a summary of ethnographic and ethnohistoric observations regarding space use among such hunter-gatherer groups as the !Kung San and Hadza of Africa and the Aché of Paraguay. In a preview of the results of this analysis, there is behaviorally meaningful patterning in the distributions at the Jayroe site, but the distributions do not fully conform to simple expectations derived from ethnographic/ethnohistoric observations, and they are not always easy to interpret. There likely are two main reasons for this: (1) Toyah hunters camped on this large Leon River terrace multiple times, albeit over a short span, and tended not to do all the same things in all the same places during successive occupations; and (2) the excavations were not sufficiently extensive to capture large enough sections of the camps to enable ready interpretation. Those limitations notwithstanding, a case can be made from the distributional evidence that the excavations sampled the margins of at least two household areas and intervening space for communal activities.

Table 6.10. Localities visited and sampled during the chert survey

Locality	Location	Geological/Geomorphic Unit	Cherts (context, utility)	Distance from 41HM51 (km)
1	State Highway 16 ca. 5 miles south of De Leon	Twin Mountains (Ktm) capped by high Pleistocene gravel terrace of the Leon River	Upland exposure, abundant chert and quartzite of useable size	39
3	FM 2318 at the Sabana River	Quaternary alluvium (Qal)	Gravel bar, some small gravels of chert, silicified wood, and quartzite, but not of useable size	47
4	FM 587 at the Sabana River	Quaternary alluvium (Qal)	Gravel bar, some small gravels of chert, silicified wood, and quartzite, but not of useable size	50
6	State Highway 16 at the Leon River	Quaternary alluvium (Qal)	Gravel bar, small chert and quartzite gravels, but not of useable size	50
13	U.S. Highway 183 at the Sabana River	Quaternary alluvium (Qal)	Gravel bar, some small gravels of chert and quartzite, but not of useable size	81
14	U.S. Highway and FM 2731 intersection	Thrifty and Graham (lPtg)	Upland exposure, chert and quartzite gravels, but not abundant or of useable size	80
17	County Road 328 at the Leon River	Quaternary alluvium (Qal)	No secondary cherts present	26
18	FM 1476 at the Leon River	Quaternary alluvium (Qal)	Small gravels of chert, silicified wood, and quartzite derived from Ktm, but not of useable size	20
19	FM 1702 at the Leon River	Quaternary alluvium (Qal)	No gravel bar exposed	12
20	County Road 106 at the Leon River (41HM51)	Quaternary alluvium (Qal)	A few small gravels of chert and quartzite, not a major source of material	–
21	FM 2414 at Partridge Creek	Quaternary alluvium (Qal)	Large cobbles of Edwards chert in gravels but not abundant in bedload	24
22	FM 2414 ca. 4.5 miles north of U.S. Highway 84	Edwards (Ked)	Primary cherts present	29
23	FM 2005 ca, 0.35 miles northeast of intersection with FM 1047	Edwards (Ked)	Primary cherts present	28
24	Intersection of County Roads 259 and 262	Edwards (Ked)	Primary cherts present	35
25	Intersection of County Road 259 and State Highway 16	Edwards (Ked)	Primary cherts present	39
26	FM 218 ca. 3.3 miles east of intersection with FM 573	Edwards (Ked)	Primary cherts present	39
27	FM 573 ca. 3 miles north of Mills-Comanche County line	Edwards (Ked)	No primary or secondary cherts present	42
28	FM 590 at Mercer's Gap	Edwards (Ked)	Primary cherts present	44
29	State Highway 16 at South Leon Creek	Quaternary alluvium (Qal)	Gravel bar, good-quality Edwards chert of useable size but not abundant	50
31	FM 2486 at South Leon Creek	Quaternary alluvium (Qal)	Gravel bar, good-quality Edwards chert of useable size in bedload, common but not abundant	21

Table 6.10, continued

Locality	Location	Geological/Geomorphic Unit	Cherts (context, utility)	Distance from 41HM51 (km)
32	FM 218 at Cowhouse Creek	Quaternary alluvium (Qal)	Gravel bar, good-quality Edwards chert of useable size but not abundant	26
33	U.S. Highway281 at Cowhouse Creek	Quaternary alluvium (Qal)	Gravel bar, Edwards chert of useable size, common but not abundant	22
41	FM 717 ca. 0.3 miles south of intersection with County Road 340	Ranger (lPr)	Massive chert beds 3–8 cm thick between limestone and cherty limestone facies. Beds are laterally extensive and tend to pinch out or transition to cherty limestone. Very poor fracture qualities and of limited utility	87

Ethnographic Analogy and Hunter-Gatherer Spatial Organization

Most ethnographic and ethnoarchaeological studies of contemporary hunter-gatherer groups have defined a basic structure to residential camp sites whereby tasks are organized spatially among household, communal, and special activity areas (O'Connell et al. 1991:72). Other site types, however defined, are variations on this general pattern. Household areas are the locus of a variety of residential activities and usually represent the most common aspect of base camps. Communal areas can support the same range of tasks and behaviors as household areas. Special activity areas typically have less behavioral variability and reflect a narrow range of tasks, usually one specific one, and are located peripheral to household and communal areas (O'Connell et al. 1991:72).

Researchers have noted pattern differences in camp organization and task location between Hadza, !Kung, and Aché, compared to the Alyawara and Nunamiut (Bartram et al. 1991; Binford 1978a; O'Connell et al. 1991; Whitelaw 1983). Specialized activity areas are quite common among the Nunamiut but less so among the Hadza, !Kung, and Alyawara. Household areas among the !Kung and Hadza are usually 4–8 m apart (Gargett and Hayden 1991; Gould and Yellen 1987; Yellen 1977). Among the Aché, households are separated by distances of 3.0–3.5 m (O'Connell et al. 1991:72). Australian hunter-gatherer groups space households 25–45 m apart (O'Connell et al. 1991:72).

A broad assumption that often accompanies discussions of hunter-gatherer camp organization is that there is distinct separation between male and female tasks, activity areas, and modes of refuse discard (Bartram et al. 1991; O'Connell et al. 1991:73–75). Observations for Australian groups and the Nunamiut support this assumption (Binford 1978a, 1978b; Gargett and Hayden 1991; Gould and Yellen 1987; O'Connell et al. 1991), but O'Connell and others (1991), Bartram and others (1991), and Yellen (1977) note that, among the Hadza and !Kung, there is little support. While men and women do pursue distinct sets of refuse-producing activities, the spatial separation of activity loci is frequently less than clear, especially in household and communal areas (O'Connell et al. 1991:67).

Secondary refuse zones often develop along the peripheries of household and communal areas, and camps of both the Hadza and !Kung present the same basic arrangement and association of huts, hearths, and peripheral debris concentrations (Yellen 1977:85–98). This is the basic pattern for nuclear family households, and there may be multiple discrete concentrations of features and debris that correspond to households in base camps and other site types involving composite multifamily groupings. One observation by Yellen (1977:92) regarding multihut camps is important, i.e., some portions of the site will be empty and remain empty, and it cannot be assumed that there is a “center” to the site that may correspond to hut or household arrangement. Households are mainly loci for sleeping or seeking shade with limited activity actually occurring within the structure such that interiors have very low quantities of debris compared to surrounding outside areas.

Yellen’s (1977:97) analysis of the distribution of debris and tools and the co-occurrence of certain artifact types cannot be used in every instance to infer activity areas or tool kits associated with particular tasks. In household and communal areas, co-occurrences of artifacts are, in many cases, the debris left behind from multiple different activities and overlapping use of space by several group members. Yellen (1977:97) concludes that the “corporate” arrangement of activities in camp space use may mean that the archeologist can proceed directly from debris scatters to asking questions about basic social organization. But he cautions that relying on the distributions and associations of artifact types and other classes of material to reconstruct activities may be a misleading endeavor, since special activity areas on these types of sites are uncommon. These observations have held largely true in later work by Bartram et al. (1991) and O’Connell et al. (1991).

A significant amount of spatial patterning can be due to site maintenance. As occupation intensity and formality of task organization increase, there should be an increase in maintenance behaviors, and activities will become anchored to specific locations like hearths (Kneebone 1990:50; Wandsnider 1996:343). Wandsnider (1996:347) identifies three levels of maintenance: expedient clearing, preventative maintenance, and systematic maintenance. Expedient clearing, expected at locations where occupations are brief (both expected and actual), results in a concentration of larger debris surrounding a cleared work area. The amount of cleared area is proportional to the amount of space needed to conduct the tasks and the number of people involved. Because anticipation of reoccupation is low, materials of all sizes are left where they lay upon abandonment. In contrast, at sites where preventative maintenance is done, expected at short-term occupation locations where reuse is anticipated, there is more-complete separation of cleared areas with predominantly small debris, often adjacent to hearths, and rings or crescents of mostly larger, tossed debris. Finally, systematic maintenance typically occurs in association with fixed architecture and may be accompanied by transport of refuse away from the living area and burning of debris.

Distribution of Cultural Features

Seven of the cultural features recorded for the Toyah phase component are constructed facilities, and seven are scatters of various kinds of debris (burned rocks, animal bones, mussel shells, and lithic artifacts). This section addresses the former, all of which had thermal functions and potentially could have served as focal points for activities performed at the site. Three (Features 4, 9, and 14) are shallow pits containing ash, very few or no burned rocks, and sparse botanical remains. They are interpreted as open hearths constructed in shallow pits. The other four (Features 6, 8, 10, and 16) have abundant burned rocks in shallow pits and are interpreted as small (i.e., mostly family-sized) earth ovens or open hearths in which rocks were needed for heat retention. The two groups of features likely served different functions, and it is speculated that the nonrock features could have been heat sources or general cooking facilities while the features with rocks were used for roasting or baking foods.

Figure 6.6 shows the locations of these seven features. Four are in the southwest corner of the excavation block and adjacent test excavations, two are along the southeast edge, and one is along the northeast edge. At first glance, the southwestern concentration looks promising in terms of conveying information about spatial patterning, since the three similarly sized, possible earth ovens there are spaced evenly about 5 m apart, reminiscent of some of the household spacing referenced above in the ethnographic data. But this promise probably is illusory, since Feature 6 originates deeper in the paleosol than the others and hence is not associated with them. Of course, Features 10 and 16 still could be reflecting spacing of households, but two features do not constitute a strong pattern, and the artifact evidence discussed below neither supports nor contradicts this interpretation. Further, it seems unlikely that earth ovens, even small ones, would have been inside structures. The southeastern concentration of features is interesting because it consists of one of each type (with the hearth/possible earth oven being the largest one found), suggesting some functional association between them. This is not repeated elsewhere, however, so it is hard to know if this is meaningful.

One thing that Figure 6.6 illustrates is that there is no patterning in the feature distributions relating to surface elevation. As might be expected, some of the features, i.e., the southwestern concentration, are on what was the highest part of the landscape within the block, but the other three features are on the lowest part. Apparently, these areas were not low enough to make them undesirable for camping or performing tasks. Another notable thing about the feature distributions is that they all are on or close to the margins of the excavations. This complicates interpreting their distributions, since there is no way of knowing what other features might be near them outside the excavations.

Distribution of Cultural Materials

This section examines the distributions of various classes of cultural materials. The analysis included all classes in various combinations, but only selected ones are discussed below. Table 6.11 presents descriptive statistics for these categories and illustrates that sample sizes vary dramatically. Not surprisngly, their ubiquity, as measured by the percentage of provenience units where they occur, also varies greatly. The five most populous, most widely distributed categories (vertebrate faunal remains, mussel shells, burned rocks, debitage, and total chipped stone

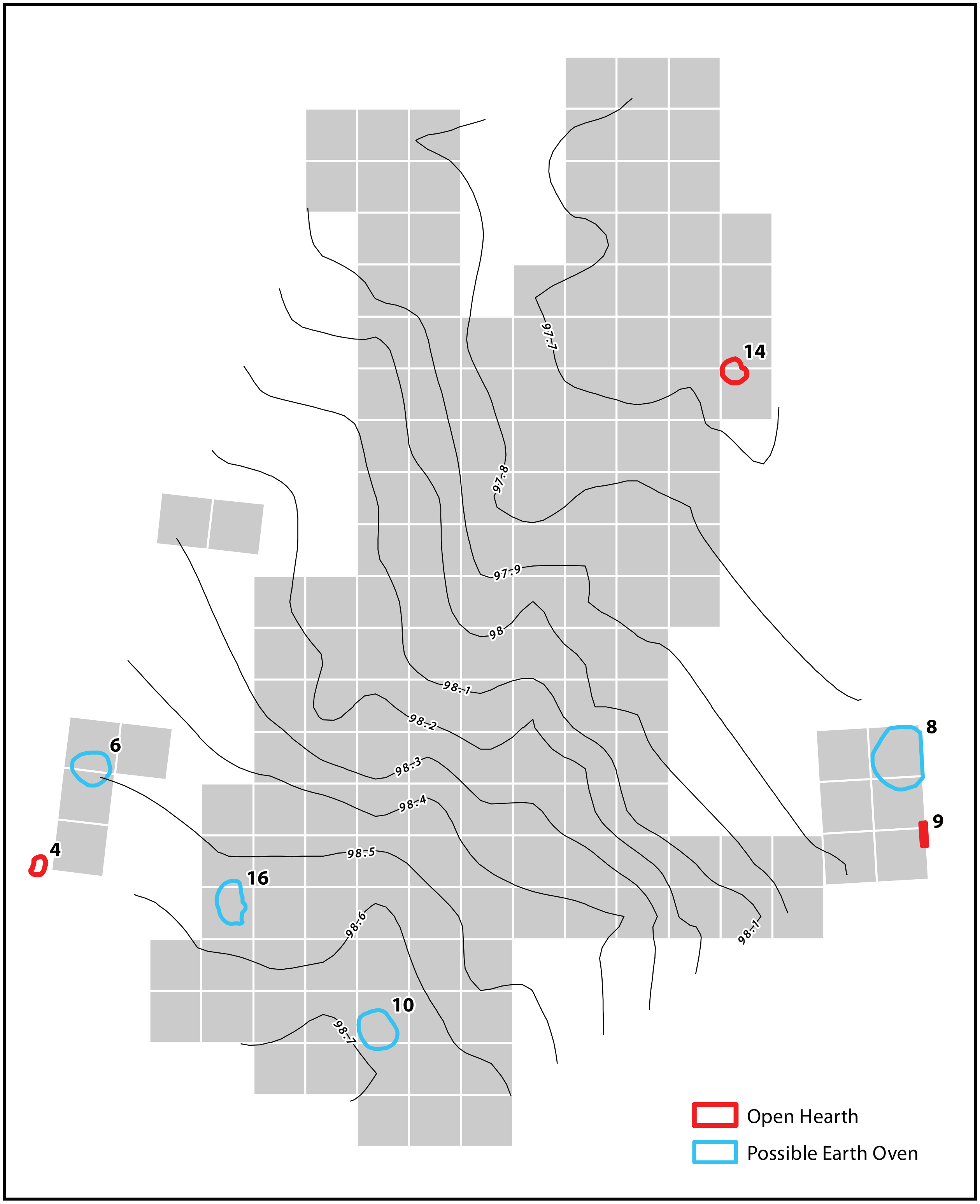


Figure 6.6. Distribution of thermal features associated with the Toyah phase component and topography of the surface of the paleosol (contour interval is 10 cm).

tools) have patterns that are obvious and relatively easy to interpret, with almost no similities between them (the 10 pair-wise correlation coefficients [r] for these are -0.16, -0.13, -0.08, -0.06, 0.00, +0.09, +0.11, and +0.16, +0.16, and +0.42, indicating no correlation in 9 cases and only a moderate positive correlation for debitage and total chipped stone tools). In contrast, the distributions of the categories with especially few items (hammerstones, anvil, slabs, manos, and polishing stone) are hard to interpret, not amenable to examination using statistics such as correlation coefficients, and likely less meaningful. The categories with more-moderate numbers (cores, arrow points, flake tools, potential pigment stones, and ceramic sherds) also tend to be hard to interpret, although they almost universally do not correlate spatially with one another or any of the larger classes, with correlation coefficiants ranging from -0.14 to 0.18; the sole exception is arrow points and debitage (r = 0.43), which have a moderate positive correlation. The following paragraphs discuss the results by class. The concluding paragraphs address overall patterns.

Table 6.11. Descriptive statistics for selected classes of cultural materials used in spatial analysis

	Total	Minimum	Maximum	Mean	Standard Deviation	Ubiquity
Vertebrate faunal remains	14,439.6	0	698.2	87.5	136.9	98.8%
Mussel shells	923	0	58	5.6	8.1	93.9%
Burned rocks	90.8	0	3.1	0.6	0.5	92.1%
Debitage	6,469	1	207	37.9	31.1	100.0%
Cores	23	0	2	0.14	0.37	13.3%
Chipped stone tools	315	0	9	1.9	1.9	75.2%
Arrow points	69	0	4	0.42	0.70	33.3%
Flake tools	94	0	3	0.57	0.77	42.4%
Hammerstones	8	0	1	0.049	0.215	4.8%
Anvil	1	0	1	0.006	0.078	0.6%
Slabs	4	0	1	0.024	0.154	2.4%
Manos	3	0	1	0.018	0.134	1.8%
Polishing stone	1	0	1	0.006	0.078	0.6%
Potential pigment stones	38	0	4	0.23	0.57	17.6%
Ceramic sherds	43	0	4	0.30	0.57	20.6%

Note: All quantities are counts except vertebrate faunal remains (g) and burned rocks (kg).

Figure 6.7 shows that there is one major concentration of vertebrate faunal remains covering ca. 35 m^2 in the northeast quadrant of the block (bone weight is used in the figure, but the pattern is the same using bone count). It encompasses debris scatter Features 11, 13, 15, and 17, as well as open hearth Feature 14 and knapping station Feature 18. Seven of the 9 highest-density units are here, along with 9 units with moderately high densities and 11 units with moderate densities. This large concentration contains 55 percent (by weight) of the vertebrate remains in the Toyah component and consists primarily of bison and bison-sized bones (76 percent), followed by deer and deer-sized (12 percent) and unidentified bones

(11 percent). Other small (1–5 m^2) concentrations are scattered across the block. Two could be associated with possible earth oven Features 8 and 16, with one of these also potentially associated with open hearth Feature 9. Combined, the small concentrations look much like the main concentration in that bison/bison-sized, deer/deer-sized, and unidentified bones predominate, albeit in different percentages (61, 18, and 19 percent, respectively); almost all of the minor taxa are present in both contexts. The main concentration contains bones of all sizes, and this could indicate that this was an area where animals of all kinds were butchered and bison and deer long bones were processed for marrow, with the debris left in place (i.e., it is not a dump of larger debris moved here from elsewhere). Tempering this conclusion, though, are the results of the bone fracture study, which concluded that some of the bone breakage is due to natural weathering rather than butchery and processing (see Chapter 5).

Befitting its limited importance to subsistence at the site, mussel shells occur in one main concentration covering about 15 m^2 on the west edge of the block (encompassing shell Feature 12) and in five test units just beyond that. It appears that activities related to processing shellfish were mostly outside the block to the west. The only other units with even moderate densities are three units near Features 8, 9, and 10. Mussels could have been eaten raw, or the shells could have been opened through use of heat applied in a variety of ways (e.g., steaming, roasting, boiling). The fact that the shells do not show obvious signs of burning argues against direct exposure to fire, but otherwise, there is no basis to speculate on what kinds of processing features may be outside the block to the west.

Burned rocks also have a restricted distribution (rock weight is used in the figure, but the pattern is the same using rock count). Most notable are concentrations associated with possible earth oven Features 6, 8, and 16, and to a much lesser degree Feature 10. These concentrations likely reflect cleaning of those features, and possibly other undiscovered ones outside the excavations to the southwest. There is a generally moderate-density concentration covering 11 m^2 in the south-central part not associated with any features, and there are four small, isolated concentrations in the north part of the block, also not associated with features. Two of these four are related to debris concentration Features 13 and 17.

The main class of debris from the manufacture of chipped stone tools, i.e., debitage, exhibits one main concentration and five secondary ones (Figure 6.8). The main concentration covers about 20 m^2 in the southeast quadrant of the block, unassociated with any thermal features and partly overlapping the main vertebrate faunal concentration. It has all four of the highest-density units and nine of those with moderately high densities. Seven other units have moderate densities. Several other moderate-density units are just to the northeast. The five secondary concentrations are scattered across the block. One in the northwest quadrant is large (ca. 13 m^2) but has mostly moderate densities, with a single unit with a moderately high density. The other four cover 2–4 m^2, but three are on the edges of the block and could be larger. All have one or two units with moderately high densities, with the others being moderate. Two of the secondary concentrations could be associated with open hearth Feature 9 and/or possible earth oven Features 8, 10, and 16. The

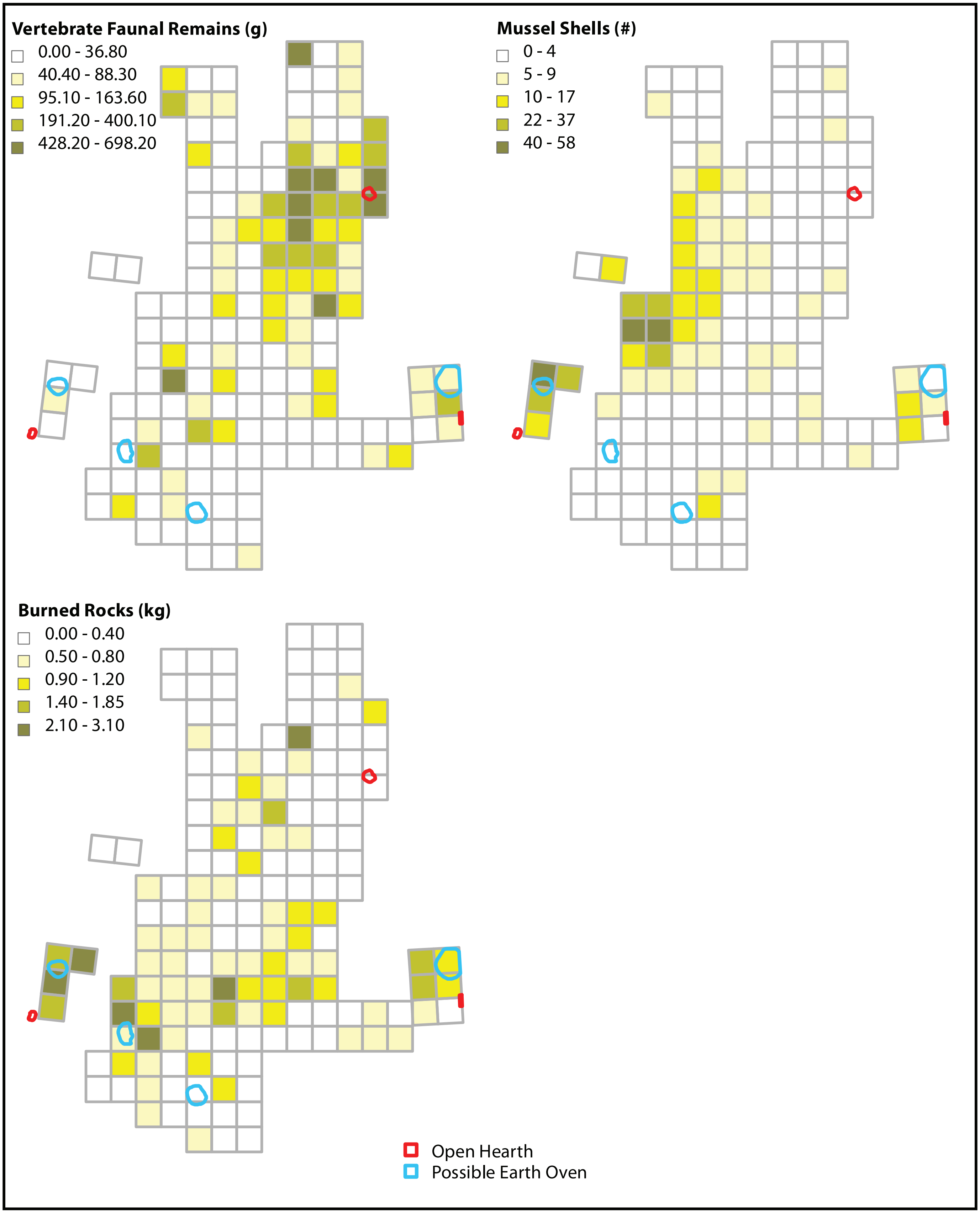


Figure 6.7. Spatial distributions of faunal remains and burned rocks in the Toyah phase component.

fact that the distribution of the debitage (particularly in terms of the single main concentration) looks largely the same regardless of flake size suggests that most of the debitage reflects in situ tool manufacture and maintenance. In other words, there is no indication that large flakes were gathered for discard somewhere other than where they were produced, while small flakes were not.

Cores, also associated with tool production, are widespread and occur in low frequencies (all but one are isolated occurrences). They do not correlate with the debitage distribution, with 11 being in debitage concentrations and 12 outside them. This lack of congruence is not surprising, since the cores and the bulk of the debitage reflect two different kinds of tasks, i.e., reduction of cores to produce flakes useable as expedient tools vs. late-stage manufacture of formal tools and repair and maintenance of those tools.

The chipped stone tools (all categories combined) are distributed differently than the debitage. Most of the units with moderate to high frequencies are dispersed in an east-west swath across the middle part of the block. Another small concentration is in the southwest corner of the block and could be associated with possible earth oven Features 10 and 16. Tools are not frequent near any of the other thermal features. Looking at the tools by category, some such as arrow points, arrow point preforms, and convex end scrapers partly correlate with the debitage distribution, while others such as flake tools, bifacial knives, other bifaces, and other unifaces do not. Figure 6.8 illustrates an example of both situations, with arrow points most common in the same place as the main debitage concentration but also present elsewhere and flake tools most common in the southwest quadrant and south-central parts of the block. This variability hints at the complexity behind how artifacts end up where they do on sites such as this.

To look more closely at this, the formal chipped stone tools are grouped according to the reason for discard, i.e., manufacture, use, purposeful truncation, and none (excludes tools for which discard reason is indeterminate). Flake tools are excluded because they are implements for which discard reason often is unknown; further, because they are expedient tools with short use lives (compared to formal tools), they probably were most often discarded where they were used. Manufacture-related discards are tools with snap/end shock, overshot, perverse, hinge/step, edge collapse, and platform loss fractures or material flaws. Use-related discards are artifacts with distal impact/bending fractures and those identified as exhausted. Truncated tools are those with radial breaks, snap breaks, or a combination of these. Tools with no apparent discard reason are ones that are complete and not exhausted.

Tools discarded for manufacture-related reasons are broadly distributed across the excavation block, but the units with the highest frequencies (n = 3 or 4) are all in the central part (Figure 6.9). Tools discarded for use-related reasons are less frequent and thus more sparsely distributed, but they too are most common across the central block, albeit in slightly different parts than manufacture-broken tools. One notable concentration of nine tools is in four adjacent south-central units. Tools that were deliberately truncated also are relatively sparse. They occur mostly singly across the south half of the block, with one concentration of three tools near

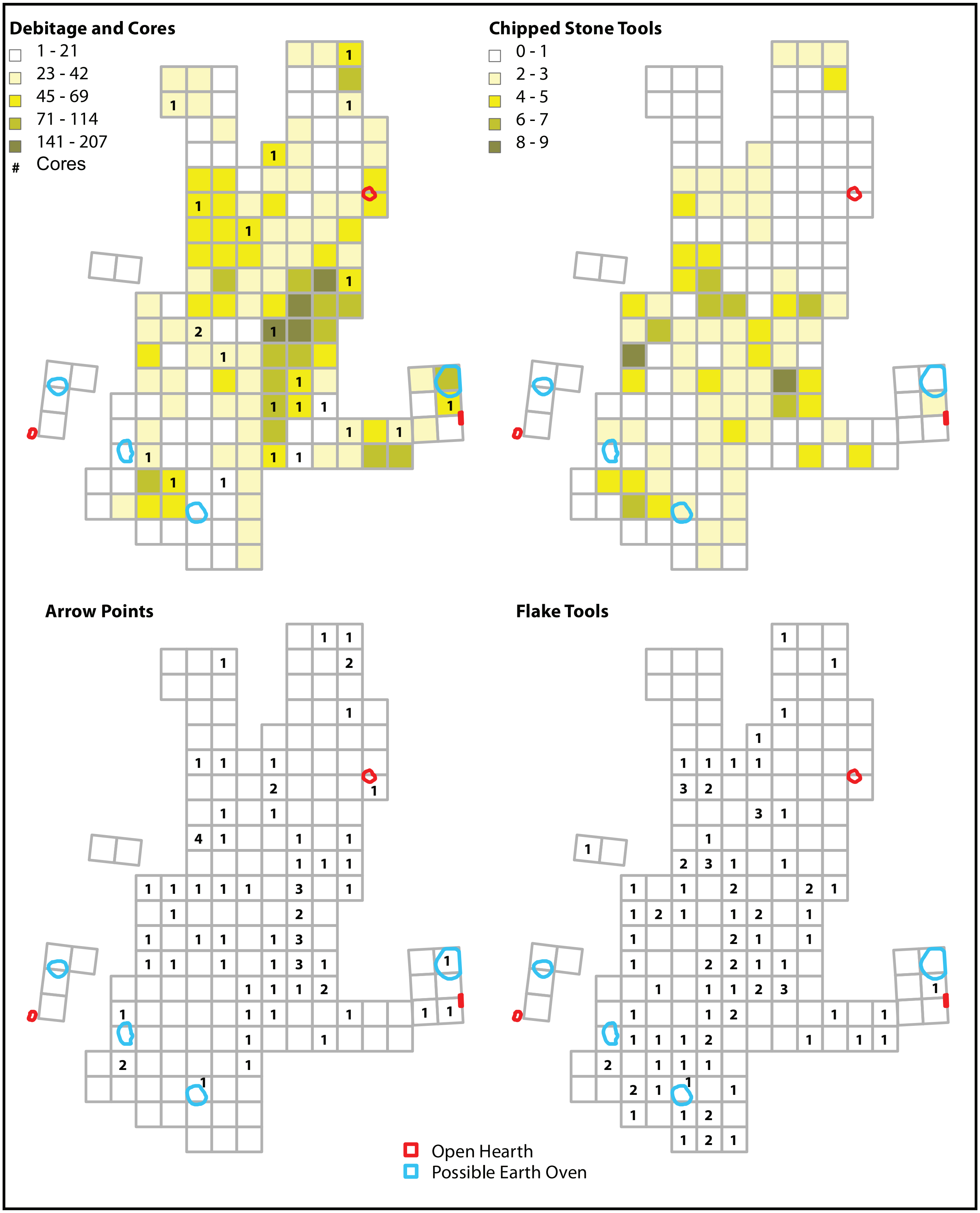


Figure 6.8. Spatial distributions of debitage, cores, total chipped stone tools, arrow points, and flake tools in the Toyah phase component.

Features 10 and 16. Finally, tools with no obvious reason for discard also are most common in the south half of the block, mostly in two diffuse concentrations (a southeast-central one and a southwestern one).

The ground and battered stones are almost all too infrequent to display any meaningful distributional patterns (Figure 6.10). The only sizeable category, potential pigment stones (only a few of which show evidence of actually having been used), is scattered widely and generally singly, mostly across the central part of the block but also north and south of there. The other categories all occur as single items, also with no concentrations and no apparent association with thermal features. Perhaps notable is the fact that none of the artifacts that might conceivably be associated with breakage of bones to obtain marrow or reduce them for grease rendering, i.e., hammerstones, manos, slabs, or anvils, are associated with the main bone concentration in the east-central part of the block, with the possible exception of two slabs, one of which contained probable unidentified meat protein residues. This may suggest that most of these tools were not used in processing bones, or, if they were, this was done somewhere else on the site.

The ceramics are distributed widely and sparsely (Figure 6.11). Twenty sherds are from a dispersed concentration in 15 units west and southwest of Feature 14: Vessel 1 (n = 9), possible Vessel 1 (n = 4), Vessel 2 (n = 5), and Vessel 3 (n = 2). Eleven sherds are from another dispersed concentration in 9 units at and west of Features 8 and 9: possible Vessel 1 (n = 3), Vessel 2 (n = 1), possible Vessel 2 (n = 1), and Vessel 3 (n = 6). There are three minor concentrations. One in four units between the main ones consists of 3 sherds from Vessel 3 and 2 possible Vessel 1 sherds. A very minor concentration at the south edge of the block consists of single sherds from Vessels 2 and 3, and a very minor concentration at the north edge consists of 2 possible Vessel 1 sherds. Ignoring the sherds assigned to vessels provisionally, all but 1 of the Vessel 1 sherds are in the north-central main concentration. Vessel 2 is mostly in the north-central main concentration (5 sherds) but also has 3 isolated sherds south of there. Vessel 3 is mostly in the southeast main concentration (6 sherds) and the minor concentration just to the west (3 sherds), but it also is in the north-central main concentration (2 sherds) and the south-edge minor concentration (1 sherd). Stated another way, Vessel 1 is significantly concentrated (90 percent) in a 6.5x3.5-m area, Vessel 2 is only moderately concentrated (63 percent) in a 4x2-m area that partly overlaps Vessel 1, and Vessel 3 is slightly more concentrated (75 percent) in a 8x4-m area that does not overlap the other two vessels. The possible Vessel 1 sherds are more dispersed than the certain Vessel 1 sherds, implying that they may represent one or more (maybe as many as four, given their distributions) other brushed vessels instead. The single sherd assigned provisionally to Vessel 2 also could instead belong to a different vessel, since it came from the east edge of the southeast concentration, well removed from most of the Vessel 2 sherds (but not all of them, as this area did contain one certain Vessel 2 sherd). Even just looking at the sherds assigned to vessels with certainty, it is clear the vessels did not break and just lie in place. Sherds were moved around after the vessels broke. Whether this was done intentionally, for example, through use of broken vessel sections as containers or scoops, or not is unknown.

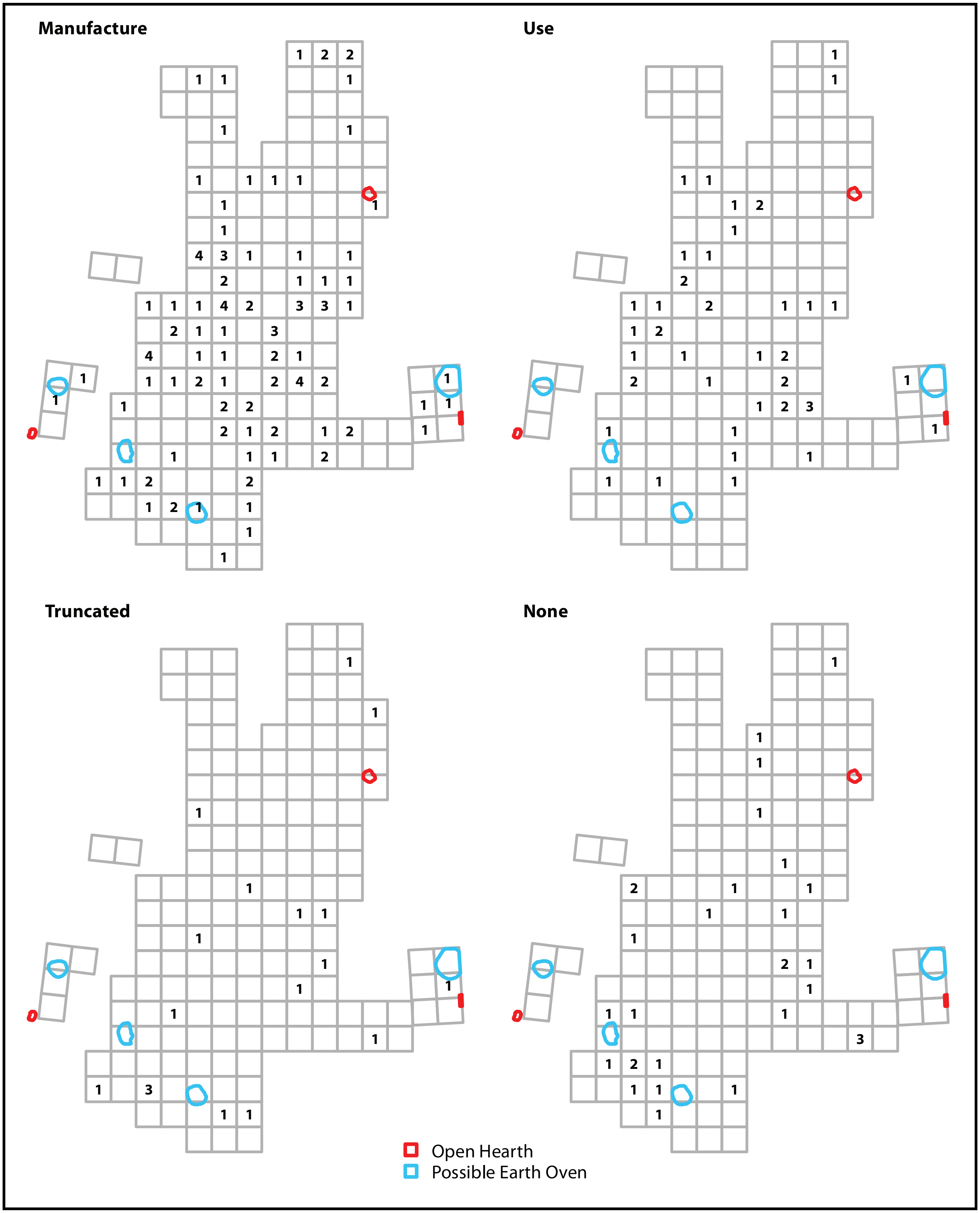


Figure 6.9. Spatial distributions of formal chipped stone tools broken down by discard reason in the Toyah phase component.

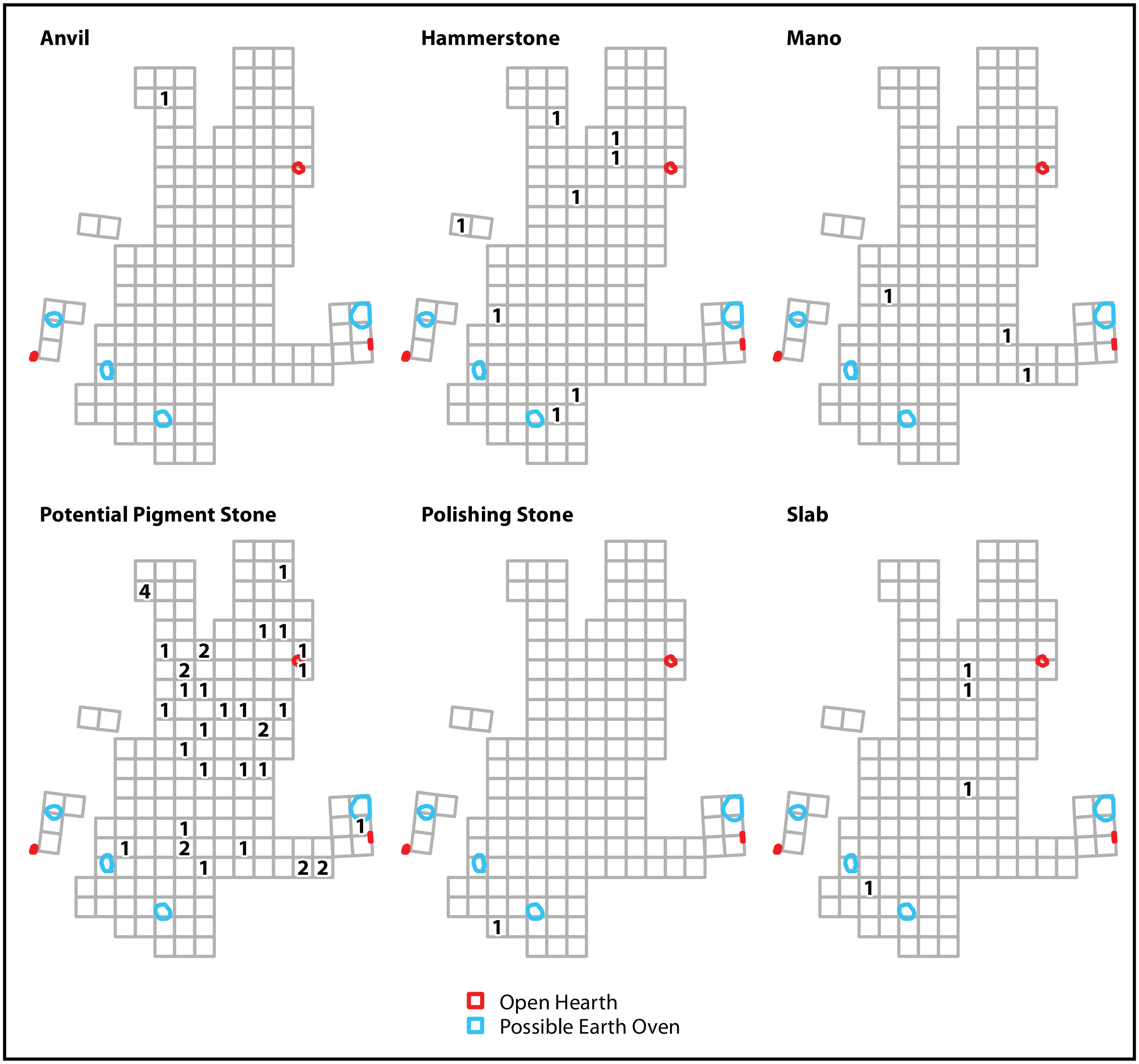


Figure 6.10. Spatial distributions of ground and battered stone tools in the Toyah phase component.

Conclusions

The various artifact and ecofact categories discussed above are not all equally informative about the use of space at the Jayroe site, and this section focuses on those categories that are most enlightening. First, though, three main observations are made. One is that, with the exception of burned rocks (many of which surely represent used hearth/earth oven stones), none of the classes of cultural materials is consistently associated with the seven thermal features at the east and southwest

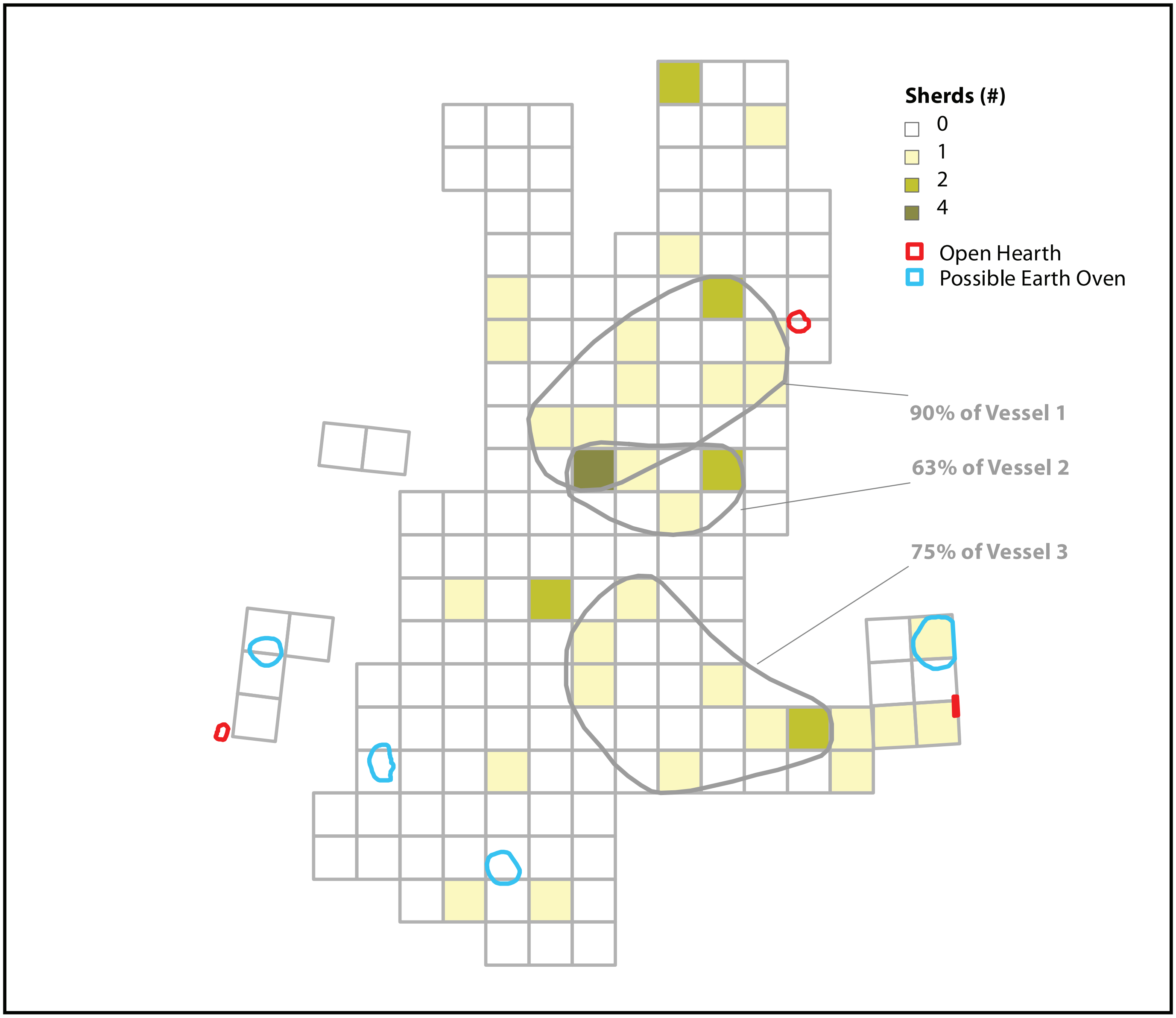


Figure 6.11. Spatial distribution of ceramic sherds in the Toyah phase component.

edges of the block. This is not to say that no kinds of remains occur in high densities near these features; some do, and these likely relate to activities performed there. But, most categories are most abundant across the central part of the block between the two feature groups (open hearth Feature 14 stands out from the others in this regard, as it is embedded within the main concentration of vertebrate faunal remains). Hence, it appears that most of the remains were deposited in open space between activity areas where thermal features were constructed and used. Because the excavations sampled only the edges of these activity areas, they are hard to interpret, but it is reasonable to think that they could represent hearth-centered household areas.

The second preliminary observation is that each class of material exhibits its own particular distributional pattern. Some are similar and some are very different, but no two are exactly alike. This implies that the central part of the block does not represent a generalized refuse area or midden because, in that situation, one would expect the distributions of the various kinds of remains to be more congruous. Further, some of the distributions are so strongly patterned that they (or parts of them) almost surely represent single occupations, or at most several occupations closely spaced in time with redundant use of space between them.

The third observation is that there does not appear to be appreciable size sorting in the distributions of the remains. Figure 6.12 illustrates this for the two most-abundant classes of debris, debitage and vertebrate faunal remains. In both cases, small and large size classes show largely the same patterns. To the extent that fracturing of these remains is due to cultural processes (completely the case for debitage and partly the case for faunal remains), the very similar distributions of small and large artifacts imply that the activities that produced the remains, i.e., chiefly late-stage reduction of lithic tools and butchering of bison and deer and subsequent processing of the bones, occurred where the concentrations are. The other alternative is that those activities occurred elsewhere, and the debris was collected wholesale and removed for disposal. This level of maintenance does not seem likely at 41HM51. Because the debitage and faunal remains appear to represent in situ activities, it seems likely that most of the other classes of remains do as well.

Six categories of materials are examined to get a sense of how the Toyah occupants of the site arranged themselves in performing activities within the excavated area: vertebrate faunal remains, mussel shells, debitage, manufacture-broken formal tools, use-broken formal tools combined with flake tools, and complete formal tools with no reason for discard. For the first three, Figure 6.13 depicts only where they are most abundant to help reduce the background noise. The latter three are depicted using counts. One large (25–30 m^2) animal (mostly bison and deer) butchery and bone-processing activity area is evident in the northeast quadrant based on high frequencies of vertebrate faunal remains. Twelve small (1–2 m^2) bone concentrations are to the north, northwest, west, southwest, south, and southeast; whether these qualify as activity areas is doubtful given their sizes, but they certainly could be small-scale butchering events. Mussel processing was not a particularly important activity at the site (at least, not in the excavated part), but what was done occurred in a restricted area at the west-central edge of the block. One must suspect that the activity area for this task was centered outside the block to the west, and the fact that mussel shell Feature 12 is deeper in the paleosol than most of the other Toyah remains indicates that it predates the other activity areas discussed here.

Chipped stone tool production, as represented by debitage, was done in two main areas. The larger (ca. 23 m^2), higher-density one is on the east side of the block, partly overlapping the main butchery activity area but extending up to 5 m south of it. The smaller (ca. 14 m^2), moderate-density one is on the west side of the block, slightly overlapping the main butchery area. The three broad groups of chipped stone tools all have generally similar distributions, being spread broadly

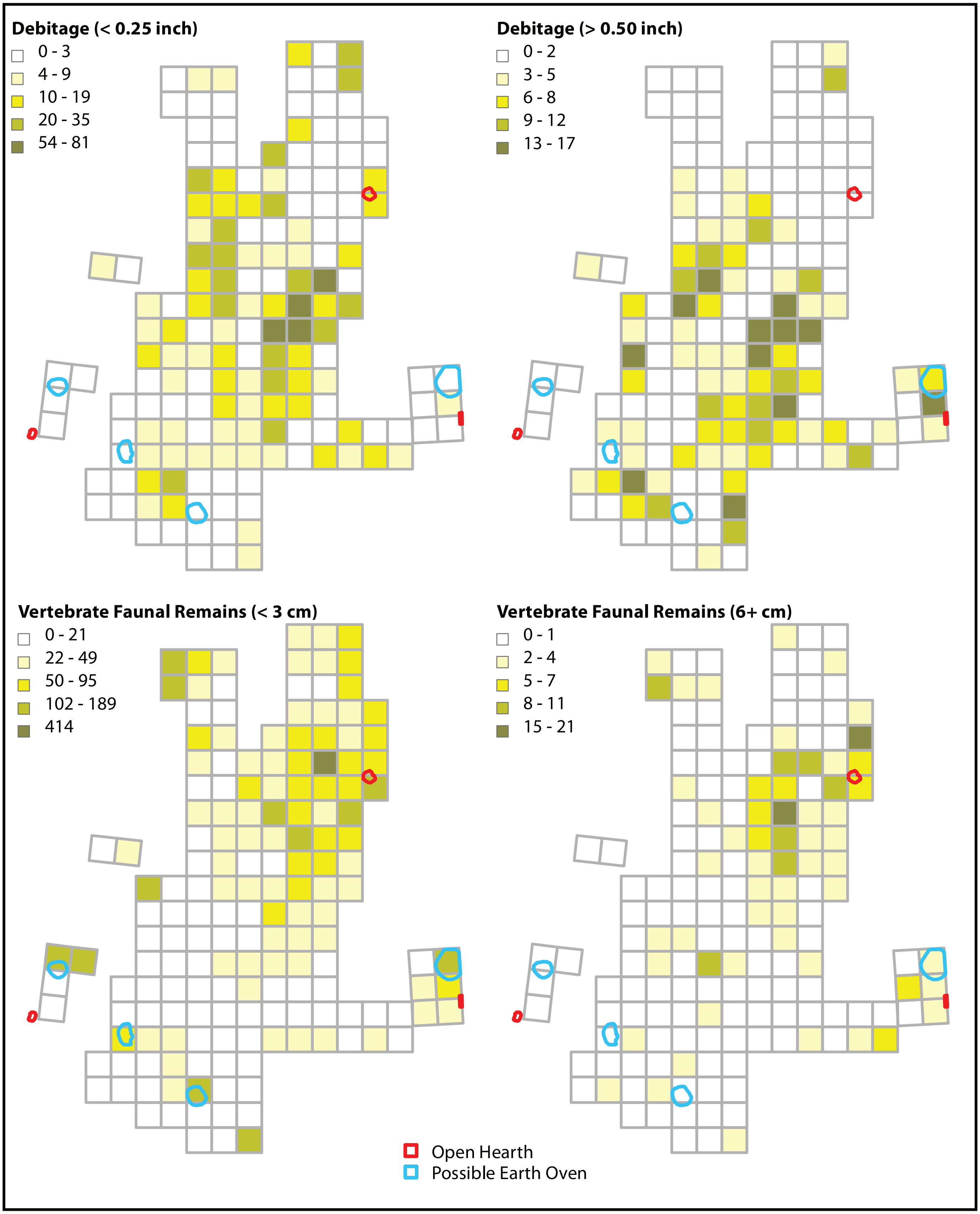


Figure 6.12. Spatial distributions of small and large size classes of debitage and vertebrate faunal remains in the Toyah phase component.

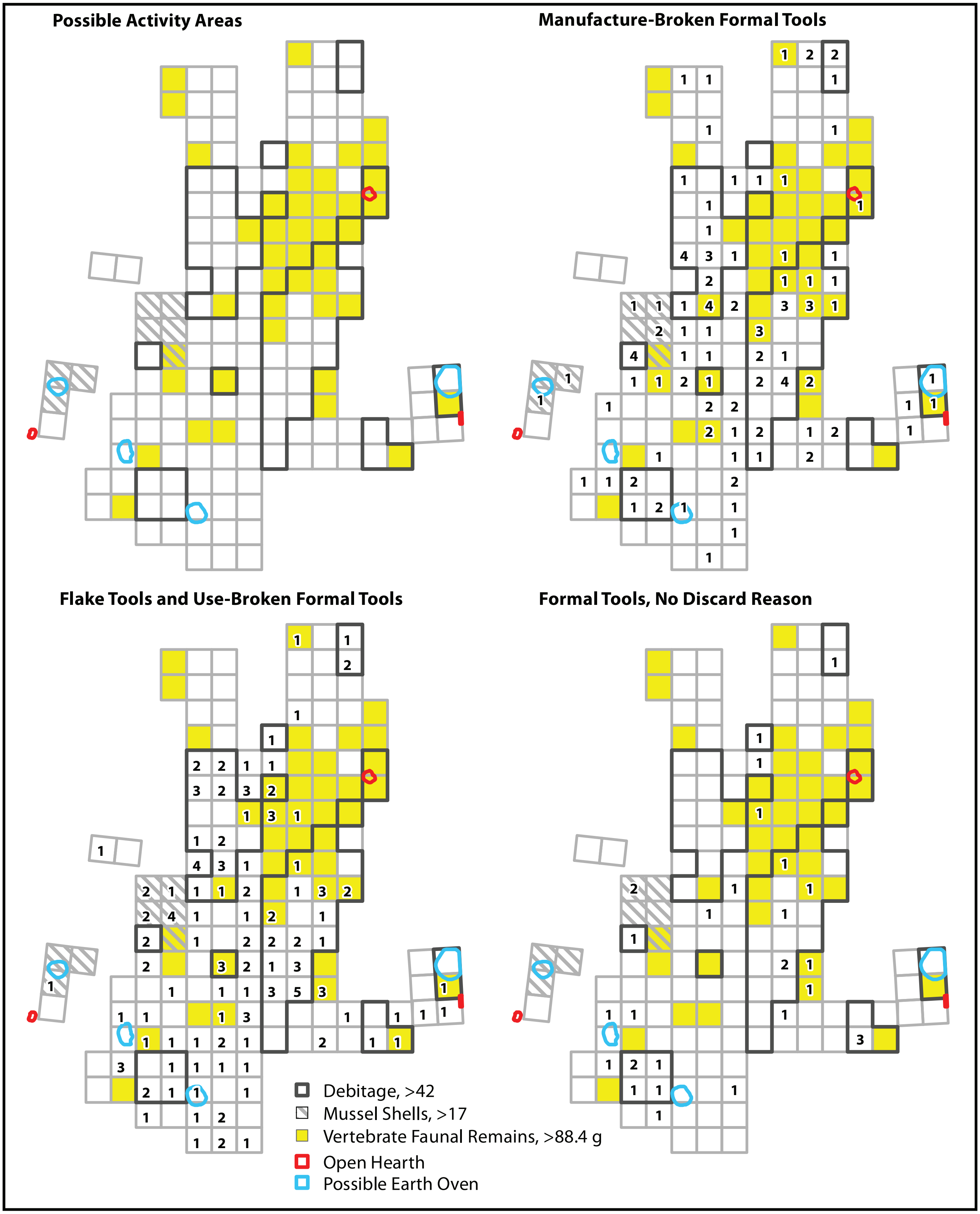


Figure 6.13. Selected artifact and ecofact distributions relevant to identifying activity areas in the Toyah phase component.

across mostly the central and southern parts of the block. Low numbers are in the mussel-processing area (4–6 percent) and the butchery/bone processing areas (7–8 percent, not counting places where both bones and debitage are abundant). Not surprisingly, manufacture-broken formal tools are most common (52 percent) where debitage is most abundant, consistent with the idea that they resulted from the same activities, i.e., tool production. But these kinds of tools also are common (37 percent) outside all of the activity areas defined by debitage, bone, and mussel shell densities. This probably indicates that tool production, finishing, and maintenance were done to some extent almost everywhere across the southern two-thirds of the block. In fact, the distributions of the other two groups of stone tools suggest that was true for the activities they represent as well. Use-broken formal tools and flake tools (i.e., those likely to have been discarded where they were used) are only slightly less common (47 percent) than manufacture-broken tools in areas with high debitage densities and slightly more common (39 percent) than them outside the tool manufacture, butchery, and mussel-processing activity areas. Complete formal tools with no obvious reason for discard (i.e., those set aside in anticipation for future use and then lost or forgotten) are slightly less common (43 percent) in tool-manufacturing areas than the other two groups and slightly more common (44 percent) in the no-activity areas.

The overall impression from the distributions is that they represent a range of activities performed in open space between or around household areas, as represented by most of the thermal features (Feature 14 may be an exception, perhaps a task-specific hearth). Some activities were more tethered than others, with butchery/bone processing and the bulk of chipped stone tool manufacture being the obvious examples (and ignoring mussel processing, since it mostly predates the main part of the Toyah occupation). Other activities were more itinerant, being performed in one place or another for reasons that are invisible archeologically. Clearly, this pattern does not conform to the hearth-centered household area camp model, nor is it consistent with secondary refuse disposal peripheral to household areas. It also does not look like specialized activity areas, although this conclusion must be tempered by the knowledge that it is impossible to separate the remains into individual episodes of use. At face value, it mostly resembles communal space used by multiple households.

INTERSITE COMPARISONS

This section compares the Jayroe site to other excavated Toyah phase sites in terms of the topics addressed previously in this chapter. The sample consists of 13 sites in four environmental settings across central and south Texas: Blackland Prairie/Lampasas Cut Plain, Edwards Plateau Canyonlands, Edwards Plateau/Rolling Plains, and South Texas Brush Country (Table 6.12). Sites are assigned to types taken from previous syntheses by Arnn (2007) and Carpenter et al. (2012), with most interpreted as residential camp sites. The sites selected are ones with larger, better-reported excavations and are drawn from lists of candidate sites in the research design TxDOT prepared for this project (see Chapter 3) and in Seikel and Feit's (2017) recent examination of evidence for bone grease production in central

Texas sites. The amount of excavation at the selected sites varies substantially (see Table 6.12). Further, not all sites have pure Toyah components, and the kinds and amounts of data from them vary in terms of its utility for comparisons.

Table 6.12. Toyah phase sites used in the comparative study

Site Name	Site No.	Setting	Reference	Site Type	Area Excavated (m^2)
Jayroe	41HM51	Blackland Prairie/Lampasas Cut Plain	This report	residential	165
Currie	41CC131	Edwards Plateau/Rolling Plains	Treece, Quigg, Miller, and O'Neill 1993	residential	227
Varga	41ED28	Edwards Plateau/ Canyonlands	Quigg et al. 2008	residential	83
Barton North	41HY202-A'	Blackland Prairie/Lampasas Cut Plain	Ricklis and Collins 1994	specialized	66
Mustang Branch	41HY209-T	Blackland Prairie/Lampasas Cut Plain	Ricklis and Collins 1994	specialized	123
Hinojosa	41JW8	South Texas Brush Country	Black 1986	residential	82
Buckhollow	41KM16	Edwards Plateau/Rolling Plains	Johnson 1994	residential	350
Little Paint	41KM226	Edwards Plateau/Rolling Plains	Carpenter at al. 2012	residential	102
Possum Creek	41LK201	South Texas Brush Country	Highley 1986	residential	40
Rocky Branch	41RN169	Edwards Plateau/Rolling Plains	Treece, Quigg, Lintz, and Miller 1993	residential	115
East Levee	41TG91	Edwards Plateau/Rolling Plains	Creel 1990	residential	72
Rush	41TG346	Edwards Plateau/Rolling Plains	Quigg and Peck 1995	specialized	54
Toyah Bluff	41TV441	Blackland Prairie/Lampasas Cut Plain	Karbula et al. 2001	residential	52
Rowe Valley	41WM437	Blackland Prairie/Lampasas Cut Plain	Prewitt 2012; Rush 2013	residential	387

Feature Construction and Use

At first blush, the assemblage of constructed features at the Jayroe site, consisting of just three hearths and four rock-lined hearths or earth ovens, would seem to imply that a limited range of activities were performed there (the various kinds of debris scatters are not included in this discussion, since they represent discard activities). Table 6.13 shows that 41HM51 is not unusual in this regard, however, and the generally limited variability in feature types suggests that activities were organized similarly in most Toyah camps. The two kinds of features found at 41HM51 are the only ones that occur at many Toyah sites, with hearths at 10 and rock-lined hearths/earth ovens at 9. Also frequent, but identified at only

2 sites, are ash piles associated with in situ burning interpreted as temporary hearths. Together, these three kinds of thermal features are consistently interpreted as loci of habitation and activities for nuclear family households. Other kinds of features combined constitute just 17 percent of the sample. The only sites that can be considered to have diverse assemblages are the Currie and Rocky Branch sites (41CC131 and 41RN169) on the Concho and Colorado Rivers. The former had all three kinds of thermal features, plus unlined pits, caches, postholes, and a wall trench, and the latter had the three hearth types, a cache, bone stakes, and a wall trench. The wall trenches and postholes indicate possible ephemeral structures at these sites, and they may represent camps with relatively long-term occupations

Table 6.13. Summary of constructed cultural features at 14 Toyah phase sites

Site	Hearth	Temporary Hearth	Rock-Lined Hearth/ Oven	Unlined Pit	Burned Clay Pit	Bone-Filled Pit	Cache	Posthole	Stake or Peg	Wall Trench	Totals
41HM51	3	0	4	0	0	0	0	0	0	0	7
41CC131	11	10	4	3	0	0	2	4	0	1	35
41ED28	0	0	4	0	0	0	0	0	0	0	4
41HY202-A'	1	0	0	0	0	0	1	0	0	0	2
41HY209-T	1	0	0	0	0	1	0	0	0	0	2
41JW8	3	0	0	0	0	0	0	0	0	0	3
41KM16	1	0	10	0	0	0	0	0	0	0	11
41KM226	3	0	2	0	0	0	0	0	0	0	5
41LK201	0	0	0	0	0	0	0	0	0	0	0
41RN169	1	30	1	0	0	0	1	0	3	1	37
41TG91	0	0	7	0	0	0	0	0	0	0	7
41TG346	4	0	0	0	0	0	0	0	0	0	4
41TV441	0	0	9	1	0	0	0	3	2	0	15
41WM437	1	0	14	0	3	0	0	0	0	0	18
Totals	29	40	55	4	3	1	4	7	5	2	150

Previous comparisons of Toyah phase sites have included consideration of features (e.g., Arnn 2007:Table 9.1; Carpenter 2017:12–13), but direct comparisons have been limited and generally remark on the similarities of features among Toyah sites and their differences when compared to similar features in Archaic and early Late Prehistoric sites. In general, feature construction at Toyah sites was rather simple, representing low investments of labor and time, particularly in comparison to the earth ovens and slab-lined hearths of the Archaic and early Late Prehistoric periods (Carpenter 2017:12). Hearths and rock-lined hearths/ovens at Toyah sites are small and relatively shallow and exhibit limited episodes of clean-out and reuse compared to their Archaic counterparts. Even the slab and rock-lined hearths at the East Levee site (41TG91) in Tom Green County do not represent significant accumulations of burned rocks and refuse characteristic of earlier periods (Creel 1990). Carpenter (2017:12–13) emphasizes that this likely represents differences in the frequency of re-occupation of the same locations over time, with Toyah people not anticipating intensive, regular reuse. The scarcity of storage features and caches, and a lithic technology that emphasized individual- and task-level provisioning of raw materials and resources also support this conclusion.

Stone Tool Assemblage Structure

Ground or battered stone tools are less frequent than chipped stone tools at all excavated Toyah sites (Table 6.14). The ratio of the former to the latter for 41HM51 (0.08:1) is only slightly higher than the average ratio (0.07:1), minus the single assemblage with a dramatically higher value (0.38:1 at 41WM437), indicating that use of tools such as manos, anvils, slabs, and hammerstones was limited at most sites. At 41WM437 where the ratio is highest, all of the ground/battered stones are hammerstones, and their distributions imply that they were used in both chipped stone tool manufacture and animal bone processing (Rush 2013:35).

Table 6.14. Summary of lithic assemblages from 14 Toyah phase sites

Site	Formal Tools	Modified Flake Tools	Cores	Debitage	Ground/Battered Stones
41HM51	221	94	23	6,469	19
41CC131	212	128	25	5,476	8
41ED28	413	1380	37	26,323	2
41HY202-A'	250	17	5	31,554	10
41HY209-T	114	57	7	6,106	0
41JW8	459	870	35	12,324	39
41KM16	344	149	115	unknown	23
41KM226	635	47	95	56,254	9
41LK201	128	83	42	unknown	13
41RN169	128	33	12	1,497	8
41TG91	318	110	108	unknown	4
41TG346	101	62	14	3,601	13
41TV441	90	76	21	unknown	10
41WM437	137	101	105	32,133	52

Looking solely at the chipped stone tool assemblages (Table 6.15), the first thing to note is the extreme variability in the frequency of modified flake tools. This is at least partly a function of differences in analytical approaches. For some assemblages (41HM51, for example), this tool class is restricted to flakes intentionally modified to serve as tools. For others (41ED28, for example), it consists of both flakes modified intentionally and those modified through use. Since these numbers are not comparable, they cannot be used to evaluate how reliant various Toyah groups were on expedient as opposed to formal tools.

Table 6.15. Summary of chipped stone tool assemblages from 14 Toyah phase sites

Site	Perdiz Points	Other Arrow Points, Preforms, and Fragments	Dart Points	Beveled Knives	Other Bifaces	End/ End-Side Scrapers	Other Unifaces	Drills, Perforators, and Gravers	Choppers	Modified Flake Tools
41HM51	41	61	1	12	54	16	20	15	1	94
41CC131	47	47	3	3	31	56	23	2	0	128
41ED28	53	163	13	7	89	50	22	16	0	1,380
41HY202-A'	41	127	0	0	78	4	0	0	0	17
41HY209-T	23	18	6	2	11	37	1	11	5	57
41JW8	99	94	0	13	182	64	3	4	0	870
41KM16	70	33	23	18	96	93	0	11	0	149
41KM226	64	36	40	3	371	44	45	19	13	47
41LK201	19	38	1	12	40	14	0	4	0	83
41RN169	10	7	0	0	8	98	5	0	0	33
41TG91	36	77	13	5	43	75	64	5	0	110
41TG346	16	20	0	0	6	54	3	2	0	62
41TV441	9	16	2	3	38	5	7	4	6	76
41WM437	27	29	0	5	15	38	13	10	0	101

Note: Some numbers in this table do not match those in other summaries of Toyah phase sites (Arnn 2007:Table 9.1; Carpenter et al. 2012:200–206) because of differences in how artifact categories were combined and inclusion/exclusion of certain contexts.

Differences in analysis methods also complicate comparing some of the other numbers in Table 6.15, particularly in the following ways: (1) arrow point preforms are included under that heading where they are identified as such, but otherwise they probably are classed as “other bifaces”; (2) beveled knives are identified and listed consistently, but the antecedent and functionally equivalent unbeveled knives are not and thus often probably are lumped under “other bifaces”; and (3) choppers, or core tools, may not be identified consistently. These caveats aside, the extreme character of some assemblages is notable. The Barton North site (41HY202-A’) has a very high incidence of total arrow points and preforms (67 percent) and low frequency of scrapers and other unifaces (2 percent), consistent with its interpretation as a tool manufacturing location. Conversely, the Rocky Branch site (41RN169) has few arrow points and preforms (13 percent) and many scrapers and unifaces (81 percent) suggesting a focus on hide processing. The Jayroe site has more arrow points and preforms than the average for the 14 sites (47 vs. 38 percent) and fewer scrapers and other unifaces (16 vs. 29 percent). This may reflect more hunting-related activities (e.g., retooling of arrows and butchering of animals killed by arrows) and less hide processing, on average. Dart points are common in a handful of the collections and probably are more indicative of mixing with earlier deposits than use of these implements by Toyah peoples, although scavenging and reuse are not out of the question.

Some assemblages contain very large quantities of debitage, and sites with high debitage to formal tool ratios likely were locations where lithic reduction was a particularly important activity (the Buckhollow, Possum Creek, East Levee, and Toyah Bluff sites are excluded from consideration here, since the total quantities of debitage recovered cannot be determined reliably). The Rowe Valley site has by far the highest ratio (235:1), and it also has the highest ratio of cores to formal tools (0.77:1). These numbers probably reflect intensive exploitation of the readily available chert gravels in the adjacent San Gabriel River to create bifacial and flake tools. The Barton North site also has a high debitage to tool ratio (126:1), consistent with its interpretation as a tool manufacture location (Ricklis and Collins 1994:233–236), but the low core ratio (0.02:1) implies that reduction of nodules to create flakes was not important. At the other end of the scale, the Rocky Branch site has little debitage and few cores compared to formal tools (12:1 and 0.09:1) and appears to have been a place where tool manufacture was not a focal activity. The Jayroe site is much more similar to Rocky Branch in this respect than Rowe Valley or Barton North; its debitage to tool ratio is 30:1, and its core to tool ratio is 0.10:1. These numbers are consistent with the interpretation that much of the lithic reduction at Jayroe involved late-stage manufacture and repair of tools made of materials obtained at some distance from the site.

Ceramic Technology

Compared to other excavated Toyah sites, ceramics are very infrequent at 41HM51 (Table 6.16). Whether measured by the ratio of sherds to formal chipped stone tools or sherds per square meter excavated, Jayroe is at the low end of the scale—0.19:1 and 0.26 per m^2—compared to the averages for the other 13 sites (2.22:1 and 5.34 per m^2). Only the Barton North site has values as low as Jayroe, and it is clear that Toyah peoples did not make or use ceramic vessels much at these sites, or at least in the excavated parts. In contrast, ceramic containers were a much bigger component of the material culture at the Rocky Branch, Currie, East Levee, Rush, Hinojosa, Mustang Branch, and (especially) Possum Creek sites, where the ratio of sherds to formal tools ranges from 1.41:1 to 11.19:1 and sherd density ranges from 2.77 to 35.80 per m^2.

The Jayroe site ceramic assemblage also is distinguished by the fact that it consists entirely of vessels imported from elsewhere (i.e., east Texas). Only the even smaller collection from the Barton North site exhibits this trait. At all the other sites, the ceramics are predominantly or entirely Toyah-made wares.

Bone Tool Technology

The Jayroe site yielded a typically small assemblage (n = 12) of bone artifacts consisting of awl fragments, possible flakers, grooved-and-snapped pieces, a possible modified tooth, a burned/polished bone with an incised design, and a possible rasp fragment. The collection contains no modified shell artifacts. None of the excavated Toyah sites yielded large collections of such items, except for East Levee where perforated mussel shells are common (Table 6.17), undoubtedly because procurement and processing of mussels was a focal activity there. No modified bones or shells are

Table 6.16. Summary of ceramics from 14 Toyah phase sites

Site	No. of Sherds, Local	No. of Sherds, Imported	Total Sherds	Minimum No. of Vessels	Maximum No. of Vessels
41HM51	0	43 (Caddo)	43	3	8
41CC131	700	0	700	–	–
41ED28	113	1 (Jornada Mogollon)	114	5	8
41HY202-A'	0	18 (Caddo)	18	1	1
41HY209-T	443	16 (Caddo)	459	5	5
41JW8	710	0	710	–	–
41KM16	373	2 (Apachean/Puebloan)	375	19	25
41KM226	204	0	204	–	–
41LK201	1,432	0	1,432	9	–
41RN169	318	0	318	3	–
41TG91	447	0	447	18	–
41TG346	181	3	184	7	7
41TV441	22	15 (upper coast?)	37	3	–
41WM437	<122?	? (Caddo, central coast)	122?	8	–

Table 6.17. Summary of bone and shell tools and ornaments from 14 Toyah phase sites

Site	Awls	Flakers	Antler Billets	Pointed Bones/ Needles	Spatulate Bones	Grooved and Snapped Bones	Incised or Engraved	Bone or Shell Beads/ Ornaments	Other Modified Bones	Cut/Worn/ Perforated Shells
41HM51	4	3	0	0	0	2	1	1	1	0
41CC131	1	0	1	1	1	1	1	1	0	0
41ED28	1	0	0	1	0	0	0	2	0	2
41HY202-A'	0	0	0	0	0	0	0	0	0	0
41HY209-T	2	0	0	0	0	0	0	0	0	0
41JW8	1	3	0	1	0	0	2	7	0	18
41KM16	2	0	0	0	0	0	3	0	1	0
41KM226	2	0	1	0	0	0	0	2	0	0
41LK201	1	0	0	1	2	0	0	11	1	1
41RN169	0	0	0	0	0	0	2	4	0	5
41TG91	4	0	3	1	0	0	0	6	11	174
41TG346	0	0	0	1	0	1	0	3	3	0
41TV441	0	0	0	0	0	0	0	0	0	0
41WM437	0	0	0	0	0	0	0	0	0	0

reported for the Toyah Bluff and Rowe Valley sites. For the former, this probably relates to the fact that the overall assemblage is small and faunal materials are not well preserved. For the latter, it is a function of the fact that the assemblage has been only cursorily analyzed and reported (Highley [1986:118] notes that a spatulate bone tool was found in the 1981 excavations there, based on a personal communication from Grant Hall).

The overall infrequency of these kinds of artifacts implies that they were not critical to most activities performed at the sites, but their widespread occurrence indicates that the associated technologies were a consistent part of what Toyah peoples did at various places across the landscape. This is particularly true for the two largest groups (minus the perforated shells at East Levee), awls and bone or shell beads/ornaments. Just how the awls were used is unknown, although some functions in processing bison and deer hides or making basketry or other woven artifacts certainly are possibilities. The beads/ornaments indicate that personal adornment was widespread.

Food Acquisition and Processing

The first notable pattern in terms of food acquisition is the overall scarcity of mussel shells, indicating that shellfish were not a focal food resource at most sites (Table 6.18). The Jayroe site has more shells and fragments than most, but even that amount pales in comparison to the vertebrate faunal remains there. At only two sites, Possum Creek and East Levee, are mussel shells sufficiently abundant to indicate that gathering of mussels was important. The shells are not quantified for either site, but they were scattered throughout the deposits at Possum Creek (Highley 1986:137) and in both scattered and concentrated contexts at East Levee (Creel 1990:211, 222).

Based on the numbers of identified specimens, bison and deer were the main sources of protein, except perhaps at Mustang Branch where pronghorn antelope was identified in unusually high numbers (n = 475, with 1,539 of the 4,608 deer/pronghorn bones possibly being pronghorn based on the proportional identification of definite pronghorn vs. deer). While counts of bone fragments do not translate into meat yields and differences in analytical techniques make precise comparisons difficult, it is clear that the relative importance of bison and deer (and deer/pronghorn) varied from site to site. The former figured prominently at the Currie, Varga, Rocky Branch, and Rush sites, and the latter were relatively important at the Jayroe, Mustang Branch, Hinojosa, Possum Creek, East Levee, and Rowe Valley sites. As at Jayroe, at some sites deer typically were returned to the campsite as whole animals, while bison were killed elsewhere and only selected body parts brought back to camp for further processing.

Most sites have an array of smaller mammal remains (rabbits being common), birds, turtles, and fish. These tend to be most common (31–61 percent of the identified bones) in the smallest and least interpretable assemblages (i.e., Barton North, Hinojosa, Buckhollow, and Toyah Bluff), but they are notably frequent (37 percent) in the large collection from East Levee, and they are moderately common

Table 6.18. Summary of faunal remains from 14 Toyah phase sites

Site	Mussel Shells and Fragments	Animal Bones, Total	Animal Bones, Identified	Bison or Bison-Sized	Deer or Deer-Sized	Pronghorn	Small–Medium Mammal	Bird	Turtle/Tortoise	Fish	Other
41HM51	378	7,555 (14,251 g)	2,530	724	1,416	2	120	23	87	150	8
41CC131	35	26,480 (43,555 g)	3,857	3,172	209	0	389	56	18	13	0
41ED28	19	20,438 (17,349 g)	2,037	1,481	488	8	44	4	4	2	6
41HY202-A'	0	403	108	48	27	0	26	6	1	0	0
41HY209-T	few	28,737	7,526	188	4,016	2,014	276	312	476	6	238
41JW8	few	3,041 (456 g?)	412	47	110	5	88	8	115	7	32
41KM16	?	14,360	353	178	63	0	15	1	80	15	1
41KM226	176	6,188 (5,020 g)	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown	unknown
41LK201	many	<7,317 (<6,256 g)	unknown	15	121	13	273	unknown	unknown	unknown	unknown
41RN169	1	12,094 (27,271 g)	11,371	11,084	183	0	103	0	1	0	0
41TG91	many	14,029	ca. 4,486	851	1,977	0	>490	<79	463	405	221
41TG346	62	11,196 (29,132 g)	11,196	11,022	53	0	25	18	17	49	12
41TV441	39	127	14	6	5	0	3	0	3	0	0
41WM437	?	10,954 (2,580 analyzed)	416	93	284	0	39	0	0	0	0

Notes: For 41HY209-T, numbers given for deer and pronghorn include specific identifications plus proportional deer/pronghorn counts. The remains from 41LK201 are not quantified separately for the Toyah component in the UTSA field school excavations; numbers given are for upper five levels of both phases of work. For 41TG91, only Zone A-3 in Area A and Toyah contexts in Area B are included.

(12–17 percent) at the Jayroe, Currie, and Mustang Branch sites. The Rocky Branch and Rush sites, where bison bones so heavily predominate, are least diverse in this respect, with just 1 percent of those collections representing small–medium mammals, birds, turtles, and fish.

The seven assemblages that have both count and weight data vary in terms of average bone weight and hence degree of fragmentation. Those from the Rocky Branch and Rush sites have relatively high values (2.3 and 2.6 g per bone), perhaps because those assemblages are heavily dominated by bison bones, while the bones from Varga, Little Paint, and Possum Creek tend to be smaller (0.8–0.9 g per bone). The Jayroe and Currie sites have moderate values (1.6 and 1.9 g per bone). Some analysts (e.g., Quigg 2008:262; Quigg and Peck 1995:117) have interpreted these data as reflecting intensive processing to produce bone grease, but the fracture freshness index and fragmentation study presented in Chapter 5 of this report indicates that marrow extraction was more common than bone grease rendering at the Jayroe site. Rush's (2013:90–97) similar analysis for the Rowe Valley site reaches the same conclusion regarding limited bone grease production, as does Gilmore's (2012:124) analysis of remains from 41SP220, a largely unanalyzed and reported (except for the faunal remains) Toyah site in south Texas. In contrast, the analysis of the bones from the Mustang Branch site, which examined multiple aspects of fragmentation (i.e., long bone splinter/articular end ratios, phalange breakage, presence/absence of optimal grease production elements, MAU ratios, and proximal/distal articular end ratios) concluded that processing for grease production was an important activity there (Masson and Holderby 1994:474–482).

The excavated Toyah sites are universally uninformative about the use of plant foods. Five sites, mostly those with older excavations, have no plant remains reported, and even those excavated recently, including Jayroe, have such sparse remains that little can be said about what plants Toyah peoples processed and ate there (Table 6.19). As noted previously, this is at least partly a function of the poor preservation of plant remains.

Procurement of Other Resources

Most reports on excavations at other Toyah phase sites do not address procurement of other resources (e.g., firewood and raw materials for production of tools and construction of thermal features) directly, if at all. However, much of what can be gleaned from the reports is generally similar from site to site. For example, as at Jayroe, most of the wood charcoal appears to represent opportunistic collection of fuel woods near the sites, as opposed to collection of specific fuels that grew away from them. Oak is nearly ubiquitous and is prominent at Jayroe, Varga, Buckhollow, and Toyah Bluff; pecan is especially important at East Levee; and mesquite/acacia is prominent at Hinojosa and Buckhollow. Other fuel woods include elm/cedar elm, hackberry, persimmon, cottonwood, buckeye, ash, walnut, willow, mulberry, hawthorn, blackhaw, dogwood, and soapberry.

Rocks used in thermal features (limestone and sandstone) were available locally at all sites and hence presented no procurement challenges, and the same

Table 6.19. Summary of possible plant food remains from 9 Toyah phase sites

Site	Pecan	Acorn	Walnut	Seeds	Tubers and Bulbs	Other
41HM51	x	x		hawthorn	Indian breadroot	
41CC131				hackberry		
41ED28	x		x	cheno-am		agave heart and leaf
41HY202-A'				sedge, spurge, grass, mint		
41HY209-T				bedstraw		
41JW8				persimmon, chenopodium, sunflower		
41RN169		x				
41TG346			22	mesquite, hackberry		
41TV441				plantain, purslane, carpet weed	onion	

Note: No plant remains are reported for 41KM16. 41KM226, 41LK201, 41TG91, and 41WM437.

can be said for materials needed for manufacture of stone tools at most sites. Only at Jayroe and Hinojosa were the bulk of the cherts used to make chipped stone tools obtained nonlocally. A main source area for the former may have been about 25 km to the south, between Cowhouse Creek and the Lampasas River, and in secondary deposits along Cowhouse Creek. For Hinojosa, it appears that the closest material sources were 35–60 km away (Black 1986:45). It is possible that these distances were well within the foraging ranges of the groups who occupied these sites and that procurement of the raw materials was done simply as part of their normal rounds.

Activity Areas and Site Structure

The distributions of the cultural materials at the Jayroe site appear to represent general camp activities performed in open space between or around household areas, i.e., communal space used by multiple households. The observed pattern is not consistent with the traditional hearth-centered household area camp model described by Binford and others and evidenced at some other excavated sites, including Little Paint, Hinojosa, Rush, Currie, Rocky Branch, and Varga. At these sites, hearths represent focal points for primary activity areas that typically include a variety of discarded artifact types representative of both male and female tasks. Perdiz arrow points, various bifaces, and convex unifaces (end scrapers) are common in zones surrounding such features with lesser occurrence of artifacts like cores, flake tools, and piercing tools (Black 1986:219–235; Carpenter et al. 2012:155–156; Quigg 2008; Quigg and Peck 1995:83–106, Figure 5.19; Treece, Quigg, Lintz, and Miller 1993:226–257). At the Little Paint site, for example, Carpenter et al. (2012) note that the artifacts recovered adjacent to hearths represent a highly redundant pattern that suggests individuals or groups of individuals doing tasks requiring similar tool sets rather than segregation of tasks in more-or-less discrete activity areas. Similar findings are reported from multiple other Toyah phase sites. It is speculated that the Jayroe site looks different in this respect because the excavations were mostly in a part of the site between feature clusters.

Prewitt (2012) presents the most complete picture, albeit partly hypothetical, of what an atypically large Toyah camp may have looked like, based on the extensive excavations at the Rowe Valley site on the San Gabriel River in Williamson County. He suggests that Area A there contained six domiciles (probably tipis) and various activity areas (e.g., butchering station, meat-curing station, chipping stations, cooking areas, etc.) arranged around a mostly open plaza, with the total covering an area of about 30x40 m (Prewitt 2012:201–202). The less-extensive work in Areas B and C suggests similar patterns, opening up the possibility of multiple such encampments and providing part of the basis for Prewitt's suggestion that Rowe Valley represents a place where multiple groups (Toyah and perhaps non-Toyah) aggregated during the Fall and Winter months.

The distributional evidence also argues against Jayroe being a specialized site, as has been proposed for the Barton North and Mustang Branch sites in Hays County. Ricklis and Collins (1994:209–316) interpret the Barton North site as a location where activities focused on manufacture of chipped stone tools and the Mustang Branch site as a locale for processing bison and deer. These interpretations are based more on the kinds of remains found than their distributions, however, and it is difficult to evaluate just how specialized the activities performed there were, since other Toyah sites interpreted as residential camps have evidence of similar kinds of activities, albeit in variable amounts. Further, as with so many sites where excavation size and location are constrained (Jayroe being a particularly good example), it is hard to get a big enough view of how Native Americans arranged their activities to feel very confident about whole-site assessments of function.

The third main point gleaned from the distributional evidence at the Jayroe site is that the excavated area does not represent consistent secondary refuse disposal peripheral to household areas. This appears to be the case at other Toyah sites as well. Discard behavior involving systematic refuse cleanup and disposal is characteristic of sites occupied for longer periods of time or sites that figured prominently as primary focal points on the landscape and typically saw frequent re-occupation. That Toyah sites lack evidence for this kind of behavior suggests that occupations were typically short and re-occupations were not frequent or planned in advance.

CHAPTER 7: MOBILITY AND INTERACTION

This chapter addresses Toyah group mobility and interaction. These are topics that long have been at the core of research into Toyah archeology, touching on the broader issue of just what the Toyah phenomenon represents (e.g., Kenmotsu and Arnn 2012). The chapter starts with a summary of some of the main lines of thought about these questions. It then addresses some of the relevant evidence and closes with a summary statement.

SUMMARY OF MODELS OF MOBILITY AND INTERACTION

Many researchers have explored Toyah mobility and interaction since Kelley first defined Toyah in 1947. Chapter 1 discusses this in some detail, drawing on the many and varied treatments of the subject by others, and that discussion is dealt with only in summary fashion here (i.e., not all researchers' contributions are acknowledged, only representative ones).

In the beginning, Kelley (1955:990–993) specifically related the spread of the Toyah phenomenon to movement of the Jumano people from west Texas into central, east, and south Texas. According to this model, Toyah peoples had a high degree of residential mobility, as well as a high degree of interaction with neighbors far to the west, north, east, and south. A short time later, Jelks (1962:91, 99) countered the migration idea with the hypothesis that Toyah was an in situ outgrowth from the earlier Austin focus, and he speculated that Toyah was an entirely prehistoric phenomenon unrelated to movements of the Jumano during the historic era. He noted the presence of artifacts suggesting connections with Caddo peoples to the east, groups living on the Texas Gulf coast, and Puebloan groups to the west, suggesting that these materials arrived in central Texas via trade (Jelks 1962:94), but did not specifically address the question of how mobile Toyah peoples were.

By the 1980s, Elton Prewitt (1985:228) viewed Toyah as representing the southward expansion into central Texas of a bison-adapted subsistence pattern; he suggested it could have been part of a long-term history of southward movements of people, but he stopped short of drawing this conclusion with certainty. He noted the occurrence of Caddo pottery on some sites indicating interaction with settled villagers to the east, and less certainly artifacts suggestive of contact with coastal groups, and ascribed these to "extensive trade networks" (Prewitt 1981:84). He was not explicit concerning his thoughts about the question of mobility.

The last decade of the twentieth century was an important time in Toyah archeology. LeRoy Johnson's (1994) analysis of the lithic and ceramic technologies and stylistic attributes of assemblages from Buckhollow and other Toyah sites interpreted them as representing one or more bison-adapted groups who moved into the region from the Plains or Mogollon regions "plus local folk who were converted to the Toyah way of life and in large part came to accept alien stone tools well adapted for the hunting and processing of buffalo" (Johnson 1994:271–281). As Kenmotsu and Arnn (2012:24–25) note, Johnson viewed the Toyah as small, kin-based, low-mobility groups operating within confined territories. Artifacts from nonlocal sources, chiefly pottery from east Texas, were mostly seen as the result of trade with the Hasinai Caddo (Johnson 1994:266, 268).

Also in the 1990s, Robert Ricklis's (1992, 1994) work on the central Gulf coast and in central Texas led him to hypothesize that Toyah represents a bison-oriented technocomplex that was shared by multiple local groups across central and southern Texas rather than having been introduced by an influx of new peoples. Ricklis (1994:298, 312–313) suggests that the Toyah system was characterized by generally short-term occupations and high mobility with "concomitantly dispersed strategy of resource use" over territories of restricted size. He considered it likely that there was a high degree of interaction between neighboring groups on the local level (Ricklis 1994:312–315), with interaction with more-distant groups, especially the Caddo of east Texas, consisting of exchange of stylistic information in narrow zones at the edges of the Toyah area (Ricklis 1994:305–311).

Almost two decades would pass before the next major breakthroughs in thinking about Toyah archeology. This occurred in connection with two things: John Arnn's dissertation research and resulting University of Texas Press volume (Arnn 2012a) (which actually began as an outgrowth of the excavations at the Jayroe site, since he participated in an eventually abandoned effort to develop an overarching research design for investigating Toyah sites, including Jayroe); and Nancy Kenmotsu's research on Toyah, which resulted in an edited volume published by Texas A&M University Press (Kenmotsu and Boyd 2012b). Using archeological and ethnographic evidence combined, both concluded that many distinct groups characterized by high mobility and interaction occupied the Toyah area: "More specifically, there appears to be ample evidence that hunter-gatherers during the Toyah phase were not always small, kin-based groups whose mobility was restricted to a small portion of central Texas. Instead, these people were often described as large social aggregates composed of different groups, some speaking different languages, who traveled long distances. The formation of large, multicultural social aggregates…in central Texas may represent responses to social, political, and economic changes occurring outside of the region…as other groups carried those conflicts into the region during the early to mid-seventeenth century" (Kenmotsu and Arnn 2012:41). Arnn (2012b:68–69) goes on to call these groups and others "Tejas," based on Casanas's account of the Hasinai Caddo, where Tejas referred to 50 or so named groups who were allies of the Hasinai: "Thus, there is little doubt that the region of the Tejas included central and south Texas and was a broad social field consisting of numerous distinct groups who were all allies."

Most recently, Carpenter (2017) has suggested that Toyah is the archeological manifestation of a dual-economy system of agriculturalists from east and west Texas and groups from the Texas Gulf coast participating in seasonal, long-range bison hunting. Other groups native to central Texas could have participated in this as well. The implications of this model for mobility and interaction are obvious, i.e., both would have been high.

EXOTIC ARTIFACTS IN TOYAH PHASE SITES

In Kenmotsu and Boyd's (2012b) volume on Toyah economic and social processes, Kibler (2012:80–83) asserts that the Toyah homeland was a risk-laden environment because of variable climatic patterns, particularly in terms of rainfall, and that this environment was one of low resource predictability and fluctuating resource densities. He proposes that this created unpredictable shortfalls that the Toyah hunter-gatherers had to deal with using a variety of risk-reduction strategies, including high residential mobility and information sharing with other social groups within fluid territories. To support this argument, he presents information on the occurrence of artifacts from far-away sources in Toyah sites. Table 7.1 updates that information. Readily apparent from the data is that the variability of artifact types and raw materials is quite limited. Only three categories are listed: obsidian, marine shell artifacts or fragments, and nonlocal ceramics (a fourth category, asphaltum presumably originating on the Texas Gulf coast, is excluded because it has been found very rarely, i.e., only at a few sites in south Texas).

Nonlocal ceramics are most common, found at 15 of the 23 sites listed (Figure 7.1). Most are sherds from Caddo pots from east Texas, occurring at 11 sites mostly near the eastern edge of the classic Toyah area[2]. The exceptions are the Jayroe site a bit west of the eastern edge and the Rush site near the west edge. Two sites in the central part of the classic Toyah area yielded a total of three sherds that might be Jornada Mogollon wares from far west Texas, Apachean/Puebloan wares from eastern New Mexico, and wares local to the Rolling Plains of north Texas. The Rowe Valley site at the east edge contained one vessel that almost certainly came from the central Texas coast, and two sites in the same area have sherds that might represent upper coastal wares. Excluded from this list are sites in south Texas that have yielded pottery sherds containing asphaltum, which could have come from the Gulf coast.

Obsidian artifacts have been found at seven sites, always in small numbers. Eight items from three sites are of material from the Jemez Mountains in north-central New Mexico, and single items are from southwest new Mexico, southeast Idaho, and northwest Wyoming. One flake is from an unknown source. Five of the sites with obsidian are in the northern part of the classic Toyah area, one is in the central part, and one is in the south part.

[2] Analyses by Perttula et al. (2003) and others clearly show that almost all of the Caddo-looking pottery in Toyah sites was made in east Texas, including the type Boothe Brushed, which was defined as Toyah but now is recognized as the Caddo type Bullard Brushed or something akin to it.

Table 7.1. Summary of exotic materials from Toyah phase sites

Site	Obsidian	Marine Shell	Nonlocal Ceramics
41HM51 (Jayroe)	5 flakes and 2 refit Perdiz fragments (Jemez Mountains, New Mexico)		43 (Caddo)
41BL23 (Penny Winkle)			2 (Caddo)
41BL59	1 biface fragment (Jemez Mountains, New Mexico)		
41CC131 (Currie)	1 flake (unknown source)	3 beads (*Olivella*) 1 bead (species unknown)	
41CV41			7 (Caddo)
41CV48			8 (Caddo)
41CV344			13 (Caddo)
41CV535	1 triangular arrow point (southwest New Mexico)		
41ED28 (Varga)		1 bead (species unknown) 1 fragment (species unknown)	1 (Jornada Mogollon)
41HY202-A' (Barton North)			18 (Caddo)
41HY209-T (Mustang Branch)			16 (Caddo)
41JW8 (Hinojosa)		1 bead (species unknown) 18 fragments (*Laevicardium, Busycon,* and *Callista*)	
41KM16 (Buckhollow)			2 (Apache/Puebloan, north Texas)
41KM226 (Little Paint)	1 flake (Yellowstone, Wyoming)	1 bead (*Oliva sayana)*	
41LK51	1 core or biface fragment (Malad, Idaho)		
41LK201 (Possum Creek)		1 bead (*Prunum apicina*) 2 tinklers (*Oliva sayana*) 4 fragments (*Trachycardium* and *Chione cancellata*)	
41RN3	1 flake (Jemez Mountains, New Mexico)		
41TG346 (Rush)			3 (Caddo)
41TV40 (Collins)			613 (Caddo)
41TV42 (Smith Shelter)			27 (upper coast?)
41TV441 (Toyah Bluff)			15 (upper coast?)
41WM71 (Barker)			29 (Caddo)
41WM437 (Rowe Valley)			3 (Caddo, central coast)

Note: Information in this table is derived from Black (1986:104), Carpenter et al. (2012:131–132), Highley (1986:75–76, 115), Johnson (1994:203), Karbula et al. (2001:A-53–A-54), Kibler (2012:78–79), Prewitt (2012:200), Quigg (2008:254, 279–280, 316–319), Quigg and Peck (1995:142–143, 185–186), Ricklis and Collins (1994:225–228, 263–266), Suhm (1955:12–20), and Treece, Quigg, Miller, and O'Neill (1993c:210, 262).

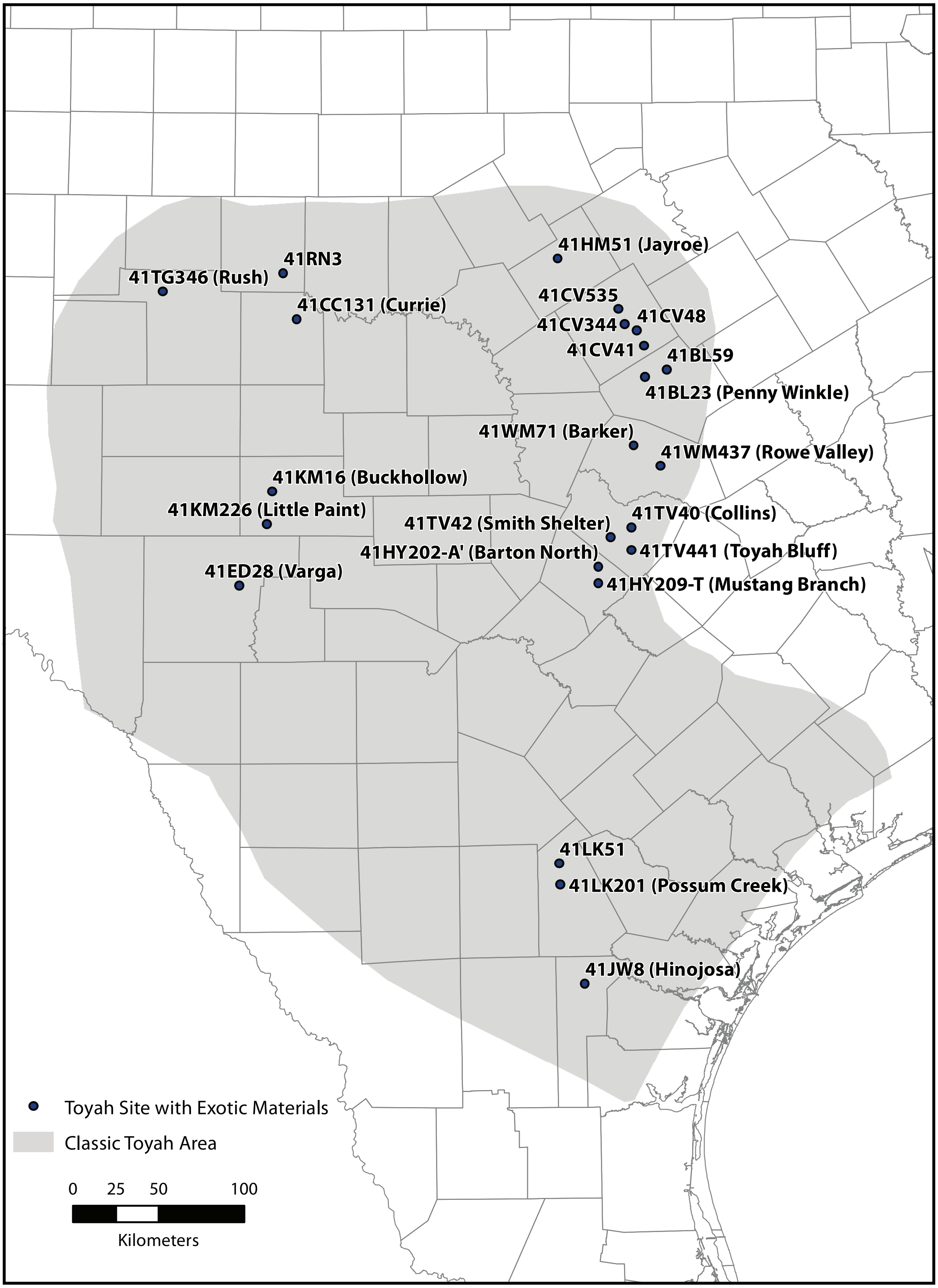


Figure 7.1. Map showing the locations of Toyah sites that have yielded exotic materials.

Marine shell ornaments and fragments have been found at five sites. Presumably, most or all of these came from the Texas Gulf coast. Two sites are in south Texas relatively close to potential source areas, and three are much farther inland in the western part of the classic Toyah area.

The three kinds of exotic artifacts tend not to occur together at the same sites. The 4 exceptions (out of 23 sites) are as follows: (1) the Jayroe site yielded both obsidian and Caddo sherds; (2) the Currie and Little Paint sites had obsidian and marine shells; and (3) the Varga site had marine shells and a possible Jornada Mogollon sherd. This indicates that different mechanisms played roles in these items becoming part of the material culture of these groups.

As noted above, trade via established exchange networks is the most commonly used explanation for the presence of these exotic items, although not the only one. Some interpretations go no further than this, while others relate these networks to efforts to buffer risk or cement long-distance alliances, for example. Vehik (2002:37; see also Spielmann 1991:11) stresses the concept of mutualism to represent the importance of such networks between mobile bison-hunting groups and more-sedentary horticulturalists, with mutualism involving the exchange of complementary resources, in this case bison products and corn, since neither alone is a sufficient dietary source of proteins and fats (calories). Vehik (2002:39–40) also discusses the concept of a southern Plains macroeconomy with cores or nodes consisting of Pueblo and Caddo villages or areas. Creel (1991:41–42) and Vehik (2002:40–42) both note the importance of bison hides and bison products in exchange between the southern Plains and Caddo heartlands, and Vehik (2002:40) speculates on the potentially greater importance of the Caddo region than the Pueblo region regarding trade with Plains groups, noting that Caddo artifacts (mainly pottery) are more common than items from the Southwest. This certainly is true for the Toyah area as well.

In terms of the scale of exchange, it appears that two distinct mechanisms were at work in the Toyah area: regular and periodic direct exchange for goods between Caddo groups and hunter-gatherer groups, and occasional acquisition of finished items of obsidian, shell, and other materials from elsewhere. Obsidian artifacts and marine shell goods are exclusively limited to finished items or fragments thereof or merely isolated flakes, and their paucity indicates they likely were not associated with established or maintained exchange networks. There is certainly not enough obsidian or marine shell material present in Toyah sites to hint at maintained supply networks, and Toyah sites lack evidence for manufacture of such artifacts from bulk materials as would be expected if networks existed. Obsidian exchange networks are documented between northeastern New Mexico source areas and Antelope Creek and Odessa phase settlements on the southern High Plains (Brosowske 2004:17–18), and one can speculate that the obsidian present in Toyah sites got there through down-the-line exchange with groups from that area or in contact with those groups.

But even down-the-line exchange seems a bit more complex than what the available evidence suggests. Renfrew (1977) discusses the archeological signatures for this type of resource acquisition, noting that a recipient of goods keeps a proportion of the material and passes on the rest (whether by trade or gift giving) to the next group who does the same. The pattern is repetitive with the amount of material decreasing with every transfer. However, within the Toyah area, there is no clear evidence of decreasing abundance of obsidian or marine shell artifacts with increasing distance from any source. These materials appear as isolated points of occurrence and seem to represent only very occasional person-to-person or group-to-group exchange rather than some higher level of organized exchange. Hughes and Hester (2009:82) use similar reasoning to explain the isolated appearance of Mexico-sourced obsidian artifacts in sites in south-central Texas. There is certainly no evidence to suggest that Toyah groups participated in or were recipients of regular redistribution of obsidian and marine shells, even if one accepted that they may have been at the end of the line of such networks. Of course, it also can be argued that the evidence of such networks would be hard to see where mobility was high and shared ranges were large.

The presence of Caddo ceramics on Toyah sites has a distinctly different explanation. There is ethnohistoric and archeological evidence for trade fairs operating between hunter-gatherer groups from the Edwards Plateau and horticultural and agricultural groups to the west and east. As noted, Kenmotsu and Arnn (2012:31–37) present considerable ethnohistoric evidence that large and small groups of Jumanos and other hunter-gatherers regularly made long-distance treks to the La Junta region in Coahuila and northern Mexico and northeast to Caddo territory and participated in extensive trade networks that often included the exchange of numbers of prisoners and bundles of deer, bison, and antelope hides. The Spanish recognized that the Jumanos were instrumental in organizing trade between hunter-gatherer groups in south Texas and Caddo groups in east Texas at which goods such as hides, meat, tools, salt, bow wood, and other items were exchanged or bartered (Arnn 2012a:129–134). Ricklis and Collins (1994:18–19, 26) note that ethnohistoric accounts frequently mention Hasinai Caddo as occupants of multigroup encampments at the east edge of the Edwards Plateau, and, assuming that such congregations occurred prehistorically too, it is easy to see them as having presented prime trading opportunities.

EVALUATING MOBILITY

Chapter 3 outlines a suite of analyses that potentially could contribute to addressing the question of how mobile Toyah peoples were, but, as described below, application of these analyses using the Jayroe site data does not yield a very satisfying result. This is because, to be truly instructive, these analyses require that the following criteria be met: (1) comparisons must involve a large set of Toyah sites; (2) data sets from the various sites must have been analyzed and reported in similar ways; and (3) the excavations at each site need to have been large enough and sufficiently well placed to provide a representative picture of what went on there. Numerous Toyah sites have been excavated, and comparisons with some of them are made in Chapter 6, but by and large the other two criteria have not yet been met. Further, for maximum results, data from Toyah sites need to be compared to those from earlier sites so that similarities and differences in patterns can be seen clearly, and this is beyond the scope of this project.

The first measure of mobility proposed in Chapter 3 is the ratio of the remains of artiodactyls to the remains of lower-ranked animal resources, which is based on the idea that artiodactyls were favored upon initial site occupation because they were readily available, they were large, and they provided abundant protein and fat. As occupation length increased (i.e., lower mobility), these prey may have become scarcer and thus the cost of acquiring them higher, and hunters may have shifted to smaller but less-productive game. Ten of the 14 sites used for comparative studies in Chapter 6 have large enough faunal samples for this kind of study (Table 7.2).

Table 7.2. Summary of artiodactyls vs. small–medium mammals and importance of mussels at 10 Toyah phase sites

Site	Artiodactyls	Small-Medium Mammals	Ratio	Importance of Mussels
41HM51	2,142	120	18	Low
41CC131	8,234	413	20	Low
41ED28	1,977	44	45	Low
41JW8	157	88	2	Low
41HY209-T	7,800	276	28	Low
41KM16	10,503	18	584	Low
41LK201	352	356	1	High
41RN169	11,737	103	114	Low
41TG91	2,828	753	4	High
41TG346	11,075	25	443	Low

In Table 7.2, numbers for all artiodactyls (i.e., bones specifically identified as bison, deer, and pronghorn, along with bones big enough to have come from those animals where so identified) are compared to bones representing small to medium mammals. Other potentially low-ranked resources (birds, turtles, fish, and reptiles) are excluded to try to circumvent identifiability- and preservation-related biases. These numbers suggest that artiodactyls were enormously favored at three sites (Buckhollow, Rocky Branch, and Rush), artiodactyls were more moderately favored at four sites (Jayroe, Currie, Varga, and Mustang Branch), and lower-ranked resources were relatively important at three sites (Hinojosa, Possum Creek, and East Levee). At face value, these values would suggest comparatively long-term occupations, and thus lower residential mobility, for at least the last group of sites. However, the patterns for Hinojosa, Possum Creek, and East Levee could have more to do with the fact that they are on the drier southern and western edges of the Toyah area, where lower-ranked resources may have been more important.

Interpreting these numbers is complicated by a variety of factors, though. Aside from differences in preservation between sites, there are potentially important differences in analytical schemes and presentation styles. Further, there is uncertainty about whether all of the small animals actually were used as food (e.g., small rodents), and there is evidence for differences in butchering practices between taxa at some sites, which could affect representation archeologically. And of course, numbers of identified bones do not translate into anything resembling meat yields. For these reasons, the ratios above can be viewed only as one part (and a biased and potentially misleading one at that) of the puzzle best used in support of other lines of evidence. For example, two of the sites with very low ratios, Possum Creek and East Levee, are the only excavated sites where consumption of mussels seems to have been at all important. Mussels are commonly interpreted as a low-ranked resource because, while they are easy to obtain (where present), they have low nutritional value. Their relative abundance at the sites where other low-ranked resources also were abundant is consistent with the idea of longer-term occupations there (although see cautionary note above). The Jayroe site offers an apt caution in this regard, though, since the distributional evidence suggests that the excavations caught only an edge of a larger mussel shell deposit. This raises the question of just how representative the excavated area is of the site as a whole, and this a concern for the other sites as well.

The second measure of mobility proposed in Chapter 3 relates to whether the occupants of a site obtained most of their firewood nearby, or whether they were there long enough to exhaust those sources and hence have to range farther (acknowledging that it was not really this simple, though, since factors other than proximity had a bearing on firewood availability). At the Jayroe site, this would have meant forays into the uplands adjacent to the river valley. Analysis results indicate that firewood procurement at Jayroe consisted of wood species that are primarily riparian or occur in both riparian and nonriparian zones (see Chapter 5), and hence most procurement of this resource could have been accomplished locally. This could suggest that the site was not occupied for long periods of time, compared to some of the Archaic components at the Britton and McMillan sites at Waco Lake, for example, where firewood depletion (evidenced by increased use of possumhaw/yaupon, juniper, and plateau live oak) argues for relatively lengthy occupations (Mehalchick and Kibler 2008:351–352). Comparative data from other Toyah sites are sparse, but what can be gleaned suggests a similar pattern of use of locally available woods. To make much of this measure, however, would require larger and better-analyzed assemblages and figuring out the thorny problem of how to quantify it.

The third measure of mobility proposed in Chapter 3 involves looking at the composition and distribution of secondary refuse dumps, with the presence of such features arguing for longer-term occupations and their absence indicating shorter-term use. Chapter 6 makes the case that most of the refuse scattered across the Jayroe site is in primary contexts representing communal work space between household areas, and that the sampled portion of the site lacks evidence for secondary discard. This supports the idea of short occupations. This could be misleading, though, since only a small part of the site was excavated, and areas that were not investigated could look much different. Thus, we do not have a good handle on overall site structure. This caveat applies to most of the other excavated sites as well, and for that reason and others it is very hard to tell if the deposits at the Varga, Buckhollow, Little Paint, Possum Creek, and Toyah Bluff sites represent primary or secondary deposition. Of the other eight sites, six appear to have mostly primary deposits (Currie, Barton North, Mustang Branch, Hinojosa, Rocky Branch, and Rowe Valley), and two may have evidence of secondary deposition (East Levee and Rush). None of these interpretations are based on distributional studies of size-graded materials, though (as was done for the Jayroe site), and it is hard to feel very confident about them. This discomfort aside, these data support the notion that most Toyah sites saw short-term use.

The fourth measure of mobility proposed in Chapter 3 involves looking at the ratio of unmodified debitage to formal chipped stone tools, with a high value indicating shorter-term occupation (i.e., high mobility) and a low value indicating the opposite. The premise is that formal tools should be most frequent where occupation length outlasted tool use life. The frequency of unmodified debitage is used as a proxy for the intensity of occupation. As discussed in Chapter 6, this ratio varies considerably among the 10 sites for which it can be calculated, from 12:1 to 235:1, and it appears that it relates more to site type and location relative to lithic sources than to occupation length. Sites that are adjacent to sources of abundant raw materials and where all stages of reduction were done have more debitage (per unit of occupation) than sites that are distant from sources and where only late-stage reduction is done. Hence, in this setting and with these kinds of sites, debitage amount is not a good proxy for intensity of occupation.

Theoretically, a measure such as the percent of formal tools among total tools might convey this kind of information. But this varies significantly, from 23 to 94 percent, for the 14 assemblages, and it is clear that this variation has much to do with use of different analytical schemes. Some analysts include use-modified flakes as expedient tools, and some include only intentionally modified flakes. Lacking comparability, using these numbers to look at occupation length and mobility would be spurious. Also relevant to this question, and similarly not useful here because of lack of comparability, would be measures based on tools with different kinds of breaks, with use-broken tools more common on sites occupied longer.

A similar conclusion can be reached for the fifth measure of mobility discussed in Chapter 3, richness and evenness indices for stone tool assemblages. The utility of these statistics relies on comparability between analyses. If tool types and artifact categories are defined differently from site to site, then the statistics have no meaning. That certainly is the case with the assemblages used in Chapter 6, and because of that, the summaries there use a mix of distinct tool types and generic, collapsed categories. Limiting the data to the most-easily identified tool types—Perdiz points, beveled knives, and end scrapers—may make the results less spurious but would omit much of the tool assemblage actually used and hence is not a good option. Jacknife richness and evenness values were calculated for the Jayroe site following Mehalchick and Kibler's (2008:27) study of sites at Waco Lake based on the following 16 chipped and ground stone artifact categories: Perdiz points, Perdiz preforms, arrow fragments, beveled knives, bifacial knives, other bifaces, end and end/side scrapers, other unifaces, drills/perforators, gravers, other flake tools, hammerstones, manos, slabs, anvil/nutting stones, and other ground stones. The resulting richness value is 1.55, and the evenness value is 1.34. Sites that functioned as generalized campsites with longer-term occupations should have higher richness and lower evenness, and specialized activity sites with shorter occupations should have the opposite pattern (Mehalchick and Kibler 2008:27). Hence, these results suggest that 41HM51 functioned as a campsite, which is consistent with the feature types and material culture. But absent comparative data, these values are difficult to evaluate in terms of Toyah mobility patterns. Further complicating the matter is that Jayroe and all the other sites saw multiple episodes of occupation, and thus their assemblages represent aggregates of behavior over spans of time. To the extent that that behavior was consistent from occupation to occupation, measures of diversity should be meaningful. Where that was not the case (or is unknowable), though, observed diversity in assemblages would be misleading.

The sixth measure proposed in Chapter 3 involves addressing anticipated mobility by looking at distances between hearths, since ethnographic evidence suggests that hearth distance is related to anticipated length of stay at hunter-gatherer residential sites, with hearths spaced closer together indicating shorter stays and greater distances indicating longer anticipated stays. For the Jayroe site, the problem with this measure is that we do not have a good handle on overall site structure and distances between household hearths. Hearths are present, but they cannot be interpreted easily as representing households, and it appears most of the excavations sampled communal space.

The seventh measure proposed in Chapter 3 involves calculating the ratio of resharpened arrow points and bifaces to those that are not resharpened. The premise is that, with most of the tool production at Jayroe having used raw materials obtained some distance away, a low incidence of resharpening would mean that the occupants visited those source areas frequently (i.e., longer moves), and a high incidence would mean they did not (i.e., shorter moves). For the Jayroe site, this ratio is 0.2:1 (8 of 41 Perdiz points and 1 of 20 knives are resharpened). There are several problems with interpreting this number, though. First, there are no quantitative data on resharpening for the other Toyah assemblages and hence nothing to compare that number to. Second, the measure is based on a premise that applies only to the two excavated sites that are well removed from raw material sources (Jayroe and Hinojosa). All the other sites have ready access to source areas, and thus the incidence of resharpening may have little if anything to do with move distance. Third, biface breakage (deliberate or otherwise) and recycling would also influence these results by making it difficult to identify resharpening. Fourth, Perdiz points may be considered single-use tools or tools with an expected short use life, and resharpening of damaged points may have been more idiosyncratic than part of the functional design.

The eighth measure proposed in Chapter 3 involves calculating a utility/mass ratio (number of working edges and their total length vs. weight) for bifacial tools. The premise is that bifaces are the optimal tool form in terms of portability and potential utility, versatility, and durability because they can have sharp but durable edges that can be resharpened repeatedly, and flakes can be removed from them for expedient use. The higher the ratio, the more suitable the tool is for use in high-mobility systems. While theoretically sound, this ratio would be meaningless for the Jayroe site because there are no comparative data from other excavated sites. To calculate indexes for other sites, the collections would need to be reanalyzed. In addition, the biface assemblage from Jayroe is not well suited to calculating this ratio because it is dominated by fragments broken via use and by deliberate snap and truncation techniques, meaning there is a dearth of complete late-stage and finished bifacial tools for which edge length measurements can be taken.

In sum, while the various ratios and indices mentioned above can be calculated for the Jayroe site and sometimes for other sites, the results generally end up being unenlightening, mostly because of the lack of comparability in analytical schemes between sites and the limited extent of excavations at most sites. If these problems were not pervasive, it would be possible to construct a matrix scoring all the sites in terms of these characteristics (and probably others based on the excavators' interpretations) to comprehensively address the issue of occupation length and mobility. That is not the case, however. This grousing aside, it is worth noting that the limited results the comparisons above do provide are consistent with the idea that most Toyah occupations were of short duration, and this could have translated into high mobility overall.

CONCLUSIONS

The Jayroe site is unlike other Toyah sites in that it alone contained obsidian and Caddo pottery, but it is not clear that this difference is meaningful. It appears there are multiple explanations for how and why exotic artifacts ended up at many Toyah sites, but the overall paucity of these items, other than Caddo pottery, argues that Toyah peoples were not central participants in networks involving exchange of large quantities of obsidian and marine shells, if such networks existed in the first place. In contrast, Toyah and Caddo peoples apparently interacted regularly via Caddo participation in hunting trips west of their homeland, large trade fairs at the east edge of the Edwards Plateau, and Toyah-facilitated trade througheast east, central, and south Texas and northern Mexico.

Jayroe and and the other sites compared present a picture of Toyah interaction and mobility that is consistent with (which is not to say providing definitve proof for) the ideas of multigroup aggregation, long-distance movement, generally short-term occupations, and development of a Tejas social field (Arnn 2012a, 2012b; Kenmotsu and Arnn 2012). Evidence for this at Jayroe includes the following: the presence of a handful of artifacts from faraway sources, mainly east Texas; the absence of evidence for repeated, intensive occupation (i.e., no secondary discard or middens); the small size of the thermal features and limited labor invested in constructing them; the abundance of bones of bison and deer compared to those of lower-ranked animals; the fact that the wood used to fuel fires on the site likely came from nearby; and the presence of a tool kit consisting of certain specialized chipped stone tool forms but little in the way of ground and battered stone tools. Many other Toyah sites exhibit these same characteristics, and these are the things, along with the lack of cemeteries, that Carpenter (2017) and others have used to argue convincingly in favor of a high level of long-distance mobility for Toyah peoples.

CHAPTER 8: SUMMARY AND CONCLUSIONS

PROJECT HISTORY

In 2003–2004, Prewitt and Associates, Inc., performed National Register of Historic Places testing and subsequent data recovery excavations at the Jayroe site (41HM51) in Hamilton County for the Texas Department of Transportation, Environmental Affairs Division (TxDOT-ENV), under Texas Antiquities Permit Nos. 3211 and 3405. The investigations were prompted by the planned replacement of the County Road 294 bridge at the Leon River (CSJ No. 0909-29-030), in compliance with Section 106 of the National Historic Preservation Act and its implementing regulations (36 CFR Part 800) and the Antiquities Code of Texas.

The project was done under eight work authorizations. The first, in August 2003–February 2004, consisted of testing fieldwork at 41HM51 and another nearby site (41HM46) and production of an interim report. The second, in April–October 2004, consisted of data recovery fieldwork, followed by preparation of an interim report. The third, in February 2005–March 2007, involved preparing a preliminary research design to guide completion of the project. The fourth, in September 2006–June 2007, was an initial attempt to implement the research design, which failed to reach fruition. The fifth, in December 2010–March 2011, consisted of limited planning efforts for finishing the project after it had on hold for several years. The sixth, in November 2013–March 2015, entailed a variety of analysis tasks and was the first successful attempt to move the project forward since completion of the fieldwork more than 9 years earlier. The seventh, in February–April 2016, consisted of preparation of a final research design for completing the project. The eighth, in March 2017–January 2019, consisted of finishing data analysis, preparing this report, and preparing the materials recovered and records for curation.

The Jayroe site was first identified during survey of new right of way for the proposed bridge replacement. Cultural materials were found in two backhoe trenches on and within a paleosol beneath a T_{1a} surface above the Leon River. Cultural materials observed consisted of chert debitage, burned rocks, charcoal, and freshwater mussel shells. No diagnostic artifacts or intact features were recovered, however, the paleosol was identical to that observed at 41HM46 across the river, which yielded a Late Archaic Ensor dart point. Further, it appeared comparable to the Leon River paleosol, which occurs in a similar geologic and geomorphic context downstream at Fort Hood and commonly contains sites dating to the Late Archaic and Late Prehistoric periods.

WORK ACCOMPLISHED

The testing consisted of the excavation of 6 backhoe trenches and 19 test units, with the latter commencing at or near the top of the paleosol, which was buried 70–200 cm below the modern ground surface. Testing identified seven cultural features. One was at the southern end of the site in Trench 4, while the other six were in Trenches 7 and 9 to the north; three appeared to be associated with the interface between the paleosol and the overlying recent alluvium, and four were beneath this interface. The excavations yielded arrow points, a dart point, other stone tools, a core and abundant pieces of debitage, ceramic sherds, abundant animal bones and mussel shells, modified bones and shell, burned rocks, and burned clay.

The test excavations showed that 41HM51 was an open campsite with two components: a Late Prehistoric Toyah phase occupation associated with the interface between the buried paleosol and the overlying recent alluvial drape and a Late Archaic occupation buried 70–90 cm into the paleosol. The Late Prehistoric component was judged to have the capacity to produce important information and thus to be eligible for listing in the National Register of Historic Places and designation as a State Antiquities Landmark. Data recovery excavations were considered warranted if adverse impacts from construction of the new bridge could not be avoided, and the Texas Historical Commission and TxDOT-ENV concurred with these recommendations.

The data recovery excavations consisted mainly of hand excavation of 153 contiguous 1x1-m units within a single block (after machine removal of the upper alluvial drape), starting at or near the top of the paleosol at 110–200 cm below the modern surface. This block was in the north part of the site, between the testing trenches that exposed the densest cultural deposits. In addition, 2 backhoe trenches and 2 manual units were excavated south of the stripped area and block excavation. The manual excavations totaled 60.1 m^3 of sediment. Eight cultural features were found and investigated, in addition to the six found in this part of the site during testing. The excavations produced all the same kinds of artifacts and ecofacts found in testing, resulting in a large and varied total assemblage.

RESEARCH DESIGN

The data recovery excavations were accomplished without the benefit of a fully developed research design because the construction schedule for the bridge replacement did not allow enough time between testing and data recovery to prepare one. However, all parties involved recognized that the Toyah phase component had the potential to contribute important information on a variety of topics, including intrasite patterning and the delineation of activity areas, subsistence and economic activities, and interregional contact and interactions, and that extensive excavations with good spatial controls (i.e., manual excavations in 1x1-m units) would be needed to realize this potential. Hence, the absence of a research design did not hinder successful completion of the field efforts.

An attempt was made to craft a research design to guide analysis of the data from the site shortly after fieldwork was finished, but this ultimately was abandoned, and about 12 years passed before work on a research design resumed. TxDOT-ENV archeologist Jon Budd initiated this by preparing a design that consisted of five hypotheses focusing mostly on the topic of extraction of bone grease to make pemmican for long-distance trade. Subsequently, Prewitt and Associates prepared a design providing an overall framework for interpreting data from the site, including data relevant to questions of bone grease production and trade. That portion of the research design focused on identifying the range of activities performed at the site, determining why the cultural materials were organized spatially the way they were, and identifying whether and how behaviors such as residential mobility and group interaction are reflected in the archeological remains. Because the Jayroe site is a manifestation of a multiregion archeological phenomenon (i.e., Toyah), it cannot be understood well in isolation, and hence the research design included comparisons between it and other Toyah sites to help understand the assemblages, activities, and behaviors identified archeologically.

GEOMORPHOLOGY

The Jayroe site is within a Holocene alluvial terrace occupying the floodplain on the north side of the Leon River. This terrace consists of a higher T_{1a} component containing the archeological materials separated from the culturally sterile lower T_{1b} component by a ca. 1-m-high scarp. The T_{1a} surface stands ca. 6 m above the river channel. The T_{1a} surface is underlain by two alluvial fills, with Toyah phase materials concentrated in the upper part of the earlier one and the lower part of the later one; the earlier unit also contains Late Archaic remains.

In the immediate area of the excavation block, the upper alluvial fill is 75–175 cm thick and exhibits a slightly modified AC-C or AC-C-AC' soil profile developed in pale brown to dark grayish brown silty clay loam to fine sandy clay loam. In some places, thin beds of very pale brown sand are interbedded with brown sandy mud laminae. An abrupt boundary separates the upper fill from the lower one, which has a 2Ab-2Bwb profile developed in grayish brown to very dark grayish brown clay loam. The 2Ab horizon represents a cumulic soil.

The Toyah phase component is just above and within the upper part of the paleosol imprinted on the lower alluvial unit. This paleosol is similar to the Leon River paleosol identified downstream at Fort Hood, and thus the lower unit at 41HM51 probably correlates to the West Range alluvium documented there. Radiocarbon dates indicate that the Toyah materials at 41HM51 date predominantly to the A.D. 1400s, and this is consistent with the 600 B.P. terminal age for the West Range unit at Fort Hood. The paleosol surface atop the West Range alluvium slopes down to the north. This is not due to truncation of that surface by erosion, and thus it appears that surface was constructional and may represent a levee. If so, the river likely occupied its current course during the Toyah occupation. The younger unit above the palesol is interpreted as Ford alluvium correlative to the deposits beneath the lower T_{1b} terrace, where cultural materials are absent. Continued deposition of Ford alluvium across the T_{1a} surface after occupation of the site eventually allowed the terrace to aggrade to the point where the northward slope is no longer topographically visible on its surface.

CULTURAL FEATURES

Fifteen cultural features were recorded at the Jayroe site, 7 during the testing phase and 8 during the data recovery investigations. A sixteenth, Feature 18, was identified after the data recovery excavations ended. It is a knapping station defined when it was noticed that all of the materials recovered from one level of one excavation unit were flakes of the same chert material. Of the other 15 features, 3 are pits containing ash and charcoal interpreted as open hearths (Features 4, 9, and 14), and 4 are pits with abundant burned rocks and charcoal interpreted as shallow earth ovens or surface hearths (Features 6, 8, 10, and 16). The other 8 are scatters of various kinds of debris, i.e., burned rocks (Features 3 and 5), animal bones (Features 11 and 15), mussel shells (Features 7 and 12), and combinations of some of these material types plus lithic artifacts (Features 13 and 17). Feature 3 was in a testing trench at the south end of the site, while the others were all in the north part where the data recovery work was done. Eleven (Features 4, 8–11, and 13–18) were found at the paleosol surface. The other 5 (Features 3, 5–7, and 12) were found at various depths (from 15 to 84 cm) below that surface.

CHIPPED STONE ARTIFACTS

The chipped stone artifacts consist of 322 tools and tool fragments, 26 cores and core fragments, and 6,985 pieces of unmodified debitage. Almost all are of Edwards chert, with the only nonchert artifacts being 5 flakes and 2 refitting arrow point fragments of obsidian and 3 flakes of quartzite. Likely source areas for the artifacts of Edwards chert are in the Cowhouse Creek and the Lampasas River basins about 25 km to the south, and a few other chert items may have originated in the Ranger and Winchell Formations in the upper Leon River basin northwest of the site, in the Fort Hood area downstream in the Leon River basin, and in the Bosque River drainage to the east-southeast. The 7 obsidian artifacts came from the Jemez Mountains in New Mexico. The quartzite flakes probably came from pebbles procured near the site.

The tool assemblage has 43 Perdiz arrow points and 12 Perdiz preforms, 2 Scallorn arrow points, single Cuney and Harrell/Washita arrow points, 24 untypeable arrow point fragments, 21 non-Perdiz arrow point preforms, single Darl and Ensor dart points, 12 beveled knives and 8 other bifacial knives, 47 other bifaces, 17 convex end unifaces, 21 other unifaces and fragments, 15 drills/perforators/gravers, 1 pebble chopping tool, and 95 flake and blade tools. The unmodified debitage is generally small, with 97 percent being 0.5 inches or less in maximum dimension, and the vast majority (88 percent) lack cortex. This indicates that the assemblage does not contain much material produced during primary reduction of nodules and cobbles. Instead, it reflects mostly late-stage manufacture and repair/maintenance of formal tools and retouch and resharpening of flake tools.

GROUND AND BATTERED STONE ARTIFACTS

The small assemblage of ground and battered stone artifacts consists of 21 tools: 8 hammerstones, 1 anvil fragment, 4 slab fragments, 3 mano fragments, 1 pebble polishing tool, and 4 small indeterminate fragments. Eleven are of sandstone, 6 are of quartzite, and 4 are of limestone. All of these materials likely were obtained locally. Also present are 38 pieces of mostly limonite, ocher, and hematite that could have been used as pigment sources; only 3 show clear evidence of such use, however. These materials also could have been procured from sources near the site.

CERAMIC ARTIFACTS

A total of 43 ceramic vessel sherds were recovered. All have grog temper, and some also have bone. Two-thirds are decorated with brushing, incising, linear appliqué, or fingernail punctations. Thirty sherds can be assigned to three vessels based on color, decoration, form, temper, and refitted sherds, and the remaining 13 sherds may or may not be parts of these vessels. If not, then they could represent up to five additional vessels based on their spatial distributions.

Vessel 1 is a medium to large jar with an everted rim decorated with horizontal incised lines. Body treatment is uncertain, but it may have been brushed. Such jars with a flat base, brushed body, and incised rim-neck are common utility wares in east Texas Caddo sites, and Vessel 1 is a Caddo-made pot likely from the Neches or Angelina River basin. Vessel 2 is a medium to large jar with an everted rim and globular body. It is decorated with tightly spaced curvilinear appliqué on the body, and perhaps horizontal lines of fingernail punctations on the rim, similar to treatments on Caddo vessels typed as Harleton Appliquéd. This is a Caddo vessel probably from the upper Sabine River or Cypress Creek basin. Vessel 3 is a rim and neck section of a small to medium jar or olla. The vessel form is consistent with the classic Toyah type Leon Plain, but the grog temper and instrumental neutron activation analysis (INAA) evidence are not. Rather, Vessel 3 appears to be an imported Caddo pot from the upper Sabine River or Cypress Creek basin.

Eleven sherds from all three vessels (including 5 possibly, but not certainly, from Vessel 1) were subjected to INAA and petrographic analysis. The key results of these studies are as follows: (1) all of the vessels are tempered primarily with grog, which links them technologically with Caddo ceramics rather than pottery made in central Texas by Toyah groups; and (2) the sherds are more consistent in their chemical composition to pottery made in east Texas than that made in central Texas. Hence, there is no doubt that all of the ceramics recovered are imports of Caddo-made wares.

MODIFIED BONE ARTIFACTS

The excavations yielded a small collection of modified bone artifacts. Most common are awls, awl fragments, and items similar to awls, represented by seven specimens. These are unidentifiable to species or skeletal element, but all appear to have been manufactured from longitudinal splinters of medium-sized to large mammal long bone shafts or metapodial fragments. Three pieces of faunal material have evidence of deliberate modification through application of the groove-and-snap technique or sawing and appear to have been used as raw materials to manufacture artifacts of indeterminate function. A single canid tooth has microscopic abrasion marks suggesting that it was polished. No indications of perforation are present on this fragmentary item, but such could have been present on the missing root portion; this artifact may have been a pendant. A small polished piece of burned bone is decorated with an incised zigzag design; this may be an awl shaft fragment. Three small portions of antler tine have wear suggesting they are modified and may have been used as pressure-flaking implements. A single small long bone fragment has shallow notches and may be part of a musical rasp.

VERTEBRATE FAUNAL REMAINS

The excavations yielded a total of 7,649 animal bones weighing 14,432.7 g. One notable characteristic is the degree of fragmentation. Only 177 bones (2.3 percent) are considered complete or nearly complete. A large proportion of the assemblage is indeterminate as to taxon, and more than half could not be identified to element. Long bones account for 768 fragments, and rib fragments (n = 1,242) and various bones of the feet (n = 122) also are well represented. The vast majority (86 percent) are 3 cm or smaller in size, and only 4 percent are larger than 6 cm.

Bison and bison-sized remains make up 9.5 percent of the entire assemblage and 27.6 percent of the identifiable assemblage. Element and body portion representation clearly indicate that fore and hind limb and hump areas were brought to the site for further processing much more commonly than the head. These bones represent a minimum of two mature males, two females, and a newborn. Fetal fragments indicate that at least one of the females was pregnant, and the fetal and newborn remains suggest that at least some of these animals were procured during late Spring. Also prominent are deer and deer-sized bones, which constitute 19.0 percent of the assemblage. All major parts of the skeleton are present, in contrast to bison, indicating that complete animals were brought back to camp for processing. At least three individuals are represented. One skull fragment has an attached antler, which indicates at least one male with unshed antlers, implying procurement during the Winter. Recovered teeth indicate at least one deer 10–15 months old plus an older individual. The remainder of the identifiable assemblage consists of small numbers of bones from small mammals such as rabbits, canids, squirrels, and rodents, along with birds, turtles, and fish.

A sample of 1,240 bones was subjected to a study of fragmentation to address the question of whether bone breakage is related to natural or cultural processes and, if cultural, whether it relates to extracting bone grease, marrow, or both. Key conclusions are as follows: (1) for the sample as a whole, most breakage is from noncultural factors, i.e., natural weathering; (2) considering only taxa and elements that are most likely to have been exploited for marrow or bone grease, bones broken naturally still are frequent, but so are ones with culturally derived breaks, implying that a significant proportion of the bones of animals butchered there were subjected to further processing; (3) much of the bone mass occurs as large fragments and whole elements or epiphyses (e.g., intact or nearly intact proximal and distal ends of long bones), which is not characteristic of assemblages processed extensively for bone grease; and (4) bones were broken open mostly to retrieve marrow rather than to facilitate rendering of bone grease, with this activity more prevalent among deer remains than bison. Why deer and bison remains were treated differently is uncertain, but it could be that they resulted from separate occupations that differed in terms of seasonality, duration, or other characteristics.

INVERTEBRATE FAUNAL REMAINS

A modest assemblage of 1,200 mussel shells was obtained, reflecting limited procurement of mussels. *Amblema plicata* is the dominant species, followed by *Lampsilis teres*. Six other identified species occur in very minor proportions. Fewer than 1 percent of the shells are burned, suggesting that the burning is incidental. None of the shells are intentionally modified. All of the taxa have been documented in major and minor drainages of central Texas, and all inhabit similar environments and are adaptable to a range of circumstances. There is no reason to think they were not obtained nearby from the Leon River.

MACROBOTANICAL REMAINS

Macrobotanical remains were recovered as carbon samples for dating and botanical lots, with additional remains retrieved from flotation samples. The former yielded only wood charcoal, most of which is elm (probably cedar elm), pecan or other hickory, and white group oak. Other much less frequent taxa are blackhaw, elm/hackberry, hackberry, mulberry, and plateau live oak. The flotation samples also contained mostly white group oak, elm, and hickory (probably pecan) wood charcoal, with other wood taxa being mulberry, hackberry, hawthorn, ash, blackhaw, dogwood, and soapberry. Most likely grew on the Leon River floodplain, but oak, elm, and hackberry wood could have been collected from the adjacent uplands also. These all represent woods used as fuel at the site, although some of these trees produce nuts or fruits that could have been exploited. Examples consist of 45 pecan nutshells and 1 acorn shell and 2 hawthorn seeds. The only other non-wood plant parts are a sedge seed and a fragment of an Indian breadroot tuber. The latter likely represents a food source, while the former may indicate use of sedges in basketry.

ANALYTICAL UNITS AND CHRONOLOGY

Analysis of the vertical distributions of the cultural materials and 24 radiocarbon dates allowed definition of four analytical units, only one of which—the Toyah phase component—has much interpretive potential. The Toyah unit can be distinguished in 12 test units and all 153 units in the data recovery block. It averages 40 cm in thickness and encompasses levels at the contact between the upper and lower alluvial units and up to 20 cm above and below this contact. These proveniences contained 14 cultural features, 6,251 flakes, 313 chipped stone tools, 49 ground or battered stones, 43 ceramic sherds, 13,512 g of vertebrate faunal remains, 860 mussel shells, and 88 kg of burned rocks. The radiocarbon assays indicate that this component dates between the early A.D. 1400s and perhaps the early A.D. 1500s, with the most intensive use in the A.D. 1470s.

Levels in just 12 data recovery units more than ca. 20 cm above the paleosol surface were assigned to an Upper analytical unit; the excavated deposits in these units were 7–48 cm thick. This unit contains 14 flakes, 0.1 g of vertebrate faunal remains, 2 mussel shells, and 0.3 kg of burned rocks. There are no temporal data, and it is likely that these are materials that were displaced upward from the Toyah component by bioturbation and hence have no contextual integrity. Excavated proveniences below the Toyah component but above the Late Archaic remains at the bottom of the excavations are assigned to a Lower analytical unit. These deposits were sampled in only 6 test units, which yielded 14 flakes, 2 chipped stone tools, 30.2 g of vertebrate faunal remains, 45 mussel shells, and 4.3 kg of burned rocks. These sediments could have been deposited in Transitional Archaic or early Late Prehistoric times, but it is likely that the cultural materials were introduced from above by bioturbation. There are no radiocarbon dates from the unit, and it is considered to have low contextual integrity.

The lowermost 20–30 cm in three test units sampled a Late Archaic component that is the fourth analytical unit. It contains a single cultural feature, 1 Ensor dart point, 20.1 g of vertebrate faunal remains, 65 mussel shells, and 3.4 kg of burned rocks. The dart point is the only chronological evidence, and it suggests an occupation between 200 B.C. and A.D. 200. The single feature is a small scatter of mussel shells rather than a constructed facility, and thus it does say much about the integrity of the deposits. In any case, the cultural remains are so sparse that little can be said about this occupation.

Finally, proveniences in seven test units and two excavation units distant from the data recovery block are unassigned in terms of analytical unit. In all cases, cultural materials are so sparse (1 cultural feature, 92 flakes, 3 chipped stone tools, 1 unmodified flake tool, 68.2 g of vertebrate faunal remains, 127 mussel shells, and 13.4 kg of burned rocks) that connecting them to the units defined for the block serves no purpose.

IDENTIFYING THE RANGE OF ACTIVITIES

Feature Construction and Use

Of the 14 cultural features identified in the Toyah component, only 7 are constructed facilities; all 7 had thermal functions. Three (Features 4, 9, and 14) are shallow pits containing ash, very few or no burned rocks, and sparse botanical remains. These are interpreted as open hearths constructed in shallow pits. The precise functions of these hearths are unknown. They could have been used as sources of heat or in cooking food or some other processing activity. In any case, rock heating elements were not part of their construction and use. Features 9 and 14 clearly originated at the paleosol surface, and Feature 4 probably did too, as it was found in the bottom of a backhoe trench and may have been truncated by the machine.

Features 6, 8, 10, and 16 all have abundant burned rocks that were key to how they were used. They also are shallow pits and have evidence of in situ burning, lack ash, and have abundant charred plant remains beneath and surrounding the burned rocks. These characteristics suggest that the concentrations of rocks in them could be heating elements in earth ovens, although the shallowness of the pits suggests they may have functioned more as surface hearths. None is large enough to suggest communal use. Features 8 and 10 retain portions of intact heating elements, and Features 4 and 16 do not, probably because heating elements were disturbed during cleaning episodes. Feature 10 has the largest rocks and Feature 8 the smallest, which may indicate more-intensive use of the latter. Features 6 and 16 tend to have moderate-sized rocks. All four have rocks that are larger than the scattered burned rocks found in nonfeature contexts around them, consistent with interpretation of these features as heating elements in earth ovens or surface features and the associated scatters as exhausted materials removed from them. A single Indian breadroot tuber fragment adds to the body of evidence that a primary function of earth ovens in central Texas was to process carbohydrate-rich plant foods. Features 8, 10, and 16 originated at the paleosol surface. Feature 6 was 21 cm below that surface and probably relates to a Toyah phase occupation predating the primary one.

Tool Production, Use, Maintenance, and Discard

Ground and battered stones are infrequent compared to flaked stone tools, and it is clear that activities requiring the former, such as use of manos, anvils, and slabs for extensive processing of plant foods and use of large anvils and hammerstones to pulverize animal bones, were not performed much at the site. In contrast, abundant arrow points, knives, and scrapers indicate that hunting and carcass processing were prominent activities performed by the Toyah occupants. The numerous flake tools may have been used in butchering and removal and preparation of deer skins and bison hides, as well as a variety of other kinds of processing tasks. Unifacial and unmodified flake tools probably were used to process smaller mammals, reptiles, and fish. Flake tools, burins, and drills were likely used in the manufacture of bone tools. The variety of tool types overall indicates activities by both males and females, pointing to use of the site by full social groups rather than gender-specific task groups.

Toyah peoples brought lithic materials to the Jayroe site in the form of unfinished bifaces, finished bifaces and projectile points, broken projectile points, and cores. They produced tools from cores and blanks, leaving evidence of all stages of manufacture, although early-stage reduction is under-represented. Most early-stage reduction was done elsewhere, presumably near where the raw materials were procured. The frequent snap/end shock fractures on broken tools reflect both manufacture and use, while breaks relating specifically to manufacture are much less common. The latter show that nonknife bifaces and arrow points were often made at 41HM51. Impact fractures on arrow points indicate return of arrows damaged in hunting to the site for replacement in preparation for future hunting forays. Resharpening on arrow points, bifacial knives, and end scrapers supports the interpretation that maintenance of tools in anticipation of future needs was done at the site. Some tools, most commonly end scrapers and battered and ground stone tools, were discarded because they had reached the end of their use lives, perhaps reflecting that these were readily replaced situational items. A variety of tools, mostly flake tools but also convex end scrapers, other unifaces, bifaces, and an arrow point preform, have deliberate radial or snap breaks. It appears this represents a strategy the Toyah used to extend the utility of raw material masses by transforming broken or worn tools that otherwise would be discarded.

The small collection of sherds from the Toyah component represents at least two medium-sized to large jars and a small jar or olla. The former probably were cooking vessels, and the olla may have been used differently, perhaps for storage. All are Caddo-made pots from east Texas, and there is no indication that the Toyah peoples who lived at the Jayroe site were themselves potters, or that they used ceramic vessels made by other Toyah groups. The occupants of 41HM51 used pots to cook food and maybe store food or drink, but they did not manufacture pots. They must have filled most of their needs for containers using other, perishable materials such as baskets and hide bags.

The small assemblage of bone artifacts from the Toyah component is not very informative about activities performed there. All that can be said is that the antler tines could have been used in making stone tools, the awls may have been used in processing hides or making basketry or other woven artifacts, and the canine tooth and incised bone functioned as personal items.

Food Acquisition and Processing and Nutrition

The faunal and floral remains and organic residues on stone tools and ceramics indicate that the inhabitants of the Jayroe site consumed a variety of kinds of animals and plants, although bison and deer were the main sources of protein. Other animals taken but clearly less important to the diet included fish, turtles, rabbits, birds, canids, carnivores, pronghorn, raccoon, squirrel, and perhaps American eel. Most of these animals likely were obtained locally from the Leon River, the floodplain around the site, or the surrounding uplands. Bison is the sole exception, as they were procured on hunting trips to more-distant locations with only high-meat-yield parts of the carcasses brought back to the site, except for younger individuals which were returned to camp as complete packages. Also procured locally but not a major contributor to the diet were mussels. Once returned to the site, bison and deer were further processed by removing the meat and breaking long bones and other elements to remove bone marrow.

The question of the importance of bone grease rendering was central to the research thrust that TxDOT promulgated. The analyses that Prewitt and Associates did concluded that bone grease rendering was not very important, and this lack of agreement with TxDOT's expectations caused conflict at times. Because of this, it is appropriate to review evidence relative to this question here. The primary evidence consists of the animal bones themselves. Specifically, the assemblage contains too many complete or nearly complete bison and deer elements that would have been prime candidates for use in retrieving bone grease to support the contention that this was an important activity (which is not say that it was never done). If it had been, these bones would have been processed to the point that they would have been unrecognizable. We did not need the FFI and size-grading studies to tell us this, but they do support this conclusion.

All other evidence is secondary or even tertiary in importance. Arguing that grease extraction was not important are the following: (1) the assemblage of tools that might have been used to pulverize bones (anvils, hammers, and choppers) is too small, and the tools themselves are too small; and (2) the assemblage of features lacks the kinds of pits and rocks typically associated with stone boiling to extract grease, with the burned rocks apparently associated with pit baking instead. Evidence that can be used to argue to the contrary is as follows: (1) with ceramic vessels in use at 41HM51, bones might have been processed in pots over fires built in the open hearths, obviating the need for stone boiling in hide-lined pits; (2) some of the ceramic vessels contained residues that might represent bison marrow; and (3) the abundance of potential pigment stones might indicate that acquisition of fat to mix with powdered pigment was important. In our view, all of these less-important lines of evidence can be countered (some more easily than others), leaving the character of the bone assemblage as the key. It indicates that Toyah peoples did not do much grease rendering at 41HM51.

Plant food sources are under-represented compared to faunal remains. Recovered plant foods consist mostly of pecan nutshells, with acorn shell, hawthorn seeds, and Indian breadroot tuber represented by just a few fragments. The scarceness of plant food remains is at least partly because of poor preservation, but the paucity of acorns also is consistent with the small size of the ground stone assemblage, since such tools would have been needed to ground acorns into flour. Indian breadroot does not require baking or other processing, although it can be baked and prepared in a number of ways. The features interpreted as possible shallow earth ovens could have been used for this purpose.

All three sources of nutritional energy—protein, lipids (fat and oils), and carbohydrates—are well represented in the foods consumed, with many being good sources of caloric energy. The vertebrates are all high in protein, and bison and deer meat, bison organ meat, and especially hardwood nuts were good sources of lipids. Primary sources of carbohydrates likely included hardwood nuts and geophytes like prairie turnip. Nuts also were sources of monounsaturated fats and essential fatty acids. Various resources contributed other vitamins and minerals. Bison and other ungulates, i.e., the primary sources of protein, are very lean animals, potentially presenting nutritional challenges for Toyah peoples. It appears that the occupants of the Jayroe site dealt with this in part by eating hardwood nuts and consumption of bone marrow.

Procurement of Other Resources

Acquiring firewood for cooking, warmth, light, drying meat, parching acorns, pretreating bison and deer long bones before breaking them to retrieve marrow, and treating some raw materials for making chipped stone tools would have been a daily task at the Jayroe site. The recovered botanical remains indicate that oak was used most often, followed by elm/cedar elm, hickory/pecan, mulberry, hackberry, hawthorn, ash, blackhaw, dogwood, and soapberry. With the exception of blackhaw, all are common in floodplain settings such as that surrounding the site, with oak, elm, and hackberry also occurring in upland settings. The Jayroe site inhabitants likely selected wood that was most common and available in the immediate site vicinity, probably focusing on cleaner-burning dead wood. Pecan, oak, and elm are all self pruning, meaning that they would have provided an ample supply of dead and seasoned wood as a locally available resource.

Easy access to rocks to use in hot-rock cooking features also would have been important. Situated on the Leon River, the site is immediately adjacent to sources of limestone like that found in the features. Quaternary alluvium and caliche/gravel exposures are also nearby and would have been secondary sources for limestone, sandstone, and small pieces of chert. Upland exposures of Cretaceous formations provided sources of sandstone, limestone, claystone, and occasional occurrences of ferrous minerals like ocher, hematite, and limonite. Limestone likely was procured very locally. Primary sources of sandstone were a bit farther away, but still within a kilometer of the site.

The vast majority of the chipped stone artifacts are of Edwards chert, and very small numbers are of other materials. Outcrops of Edwards Limestone occur at the southwest margin of the Leon River basin, but more-extensive outcrops are closer to the site in the Cowhouse Creek and the Lampasas River basins about 25 km to the south. These, and secondary deposits along Cowhouse Creek, may be where most of the chert materials represented by the chipped stone artifacts came from. A few items are of Pennsylvanian-age materials probably derived from the Ranger and Winchell Limestones about 70–75 km west and northwest of the site and from the Fort Hood area downstream in the Leon River basin and the Bosque River drainage to the east-southeast.

SPATIAL ANALYSIS AND IDENTIFICATION OF ACTIVITY AREAS

Analysis of the horizontal distributions of cultural remains revealed that there is behaviorally meaningful patterning, but the patterns do not fully conform to simple expectations derived from ethnographic/ethnohistoric observations, and they are not always easy to interpret. This likely is because of the following: (1) Toyah hunters camped here multiple times, albeit over a short time span, and did not to do the same things in the same places during each occupation; and (2) the excavations did not capture large enough portions of the camps to permit easy interpretation. Nonetheless, a case can be made that the excavations sampled the margins of at least two household areas and intervening space for communal activities.

Seven of the cultural features found are constructed facilities. All had thermal functions and potentially could have served as focal points for activities at the site. Three (Features 4, 9, and 14) are interpreted as open hearths constructed in shallow pits. The other four (Features 6, 8, 10, and 16) are interpreted as small (i.e., mostly family-sized) earth ovens or surface hearths in which rocks were needed for heat retention. The two groups likely served different functions, with the former likely used as heat sources or general cooking facilities and the latter used for roasting or baking foods.

Four of the features are in the southwest corner of the block and adjacent test units, two are along the southeast edge, and one is along the northeast edge. The fact that they all are on or close to the margins of the excavations complicates interpreting their distributions, since there is no way of knowing what other features might be near them outside the excavations. Perhaps in part because of this, it is hard to identify distributional patterns that can be seen as meaningful, for example, as reflecting spacing between households, with any degree of certainty.

The distributions of the artifacts and other materials are more enlightening. Except for burned rocks, many of which represent used hearth/earth oven stones, none of the various classes of cultural materials is consistently associated with the seven thermal features. Most categories are most abundant across the central part of the block between the two feature groups. Thus, most of the remains were deposited in open space between activity areas where the thermal features were constructed and used. Each class of material tends to exhibit its own particular distributional pattern, which implies that the central part of the block was not a generalized refuse area or midden, and because there is no appreciable size sorting in the distributions, it appears that the activities that produced the remains occurred where the concentrations are, i.e., larger debris was not collected and removed for disposal.

One large animal (mostly bison and deer) butchery and bone-processing activity area is evident in the northeast quadrant, and 12 much smaller bone concentrations elsewhere could mark small-scale butchering events. Mussel processing was not very important in the excavated area, but what was done occurred at the west-central edge of the block. Chipped stone tool production was done in two main areas. The larger, higher-density one is on the east side of the block, and the smaller moderate-density one is on the west side of the block; both partly overlap the main butchery area. The three broad groups of chipped stone tools (manufacture-broken, use-broken/flake, and complete formal with no obvious discard reason) have similar distributions across mostly the central and southern parts of the block, indicating that the activities they represent were done to some extent almost everywhere across the southern two-thirds of the excavations.

The distributions are interpreted as reflecting a range of activities performed in open space between or around household areas. Some activities were more tethered than others, with butchery/bone processing and the bulk of chipped stone tool manufacture being obvious examples. Other activities were more itinerant, being performed in one place or another for reasons that are invisible archeologically. This pattern does not conform to a hearth-centered household area camp model, nor is it consistent with secondary refuse disposal peripheral to household areas. It also does not look like specialized activity areas. At face value, it mostly resembles communal space used by multiple households.

INTERSITE COMPARISONS

Like most other excavated Toyah phase sites, the Jayroe site has a limited assemblage of constructed features, all of which had thermal functions and which likely mark loci of habitation and activities for nuclear family households. The generally limited variability in feature types suggests that activities were organized similarly in most Toyah camps, with a few exceptions having features suggestive of ephemeral structures at camps that were occupied longer. Feature construction at Toyah sites, including Jayroe, tended to be simple and represent low investments of labor and time, particularly compared to the earth ovens and slab-lined hearths of the Archaic and early Late Prehistoric periods. This may indicate differences in the frequency of re-occupation, with Toyah people not anticipating intensive, regular reuse of particular locations.

Comparing stone tool assemblages between Toyah sites is hampered by the use of varying analytical schemes by different researchers (resulting in highly variable frequencies of modified flake tools, for example), but two patterns are clear. First, ground and battered stone tools are generally infrequent, as they are at 41HM51, indicating that use of tools such as manos, anvils, slabs, and hammerstones was limited at most sites. Second, the extreme character of some assemblages is notable. For example, the high incidence of total arrow points and preforms and low frequency of scrapers and other unifaces at the Barton North site is consistent with its interpretation as a tool manufacturing location. Conversely, the few arrow points and preforms and many scrapers and unifaces at the Rocky Branch site suggest a focus on hide processing. The Jayroe site has more arrow points and preforms than average and fewer scrapers and other unifaces, probably indicating more hunting-related activities such as retooling of arrows and butchering of animals killed by arrows and less hide processing than at most sites.

Quantities of debitage relative to formal tools vary substantially. Sites with high ratios, such as Rowe Valley, probably saw intensive exploitation of readily available chert gravels procured nearby, and sites like Rocky Branch, with little debitage and few cores, were places where tool manufacture was less important. The Jayroe site is much more similar to Rocky Branch in this respect than Rowe Valley, with much of the lithic reduction at Jayroe involving late-stage manufacture and repair of tools made of materials obtained at some distance from the site.

Compared to other excavated Toyah sites, ceramics are very infrequent at 41HM51, and it is clear that Toyah peoples did not make or use ceramic vessels much there. The assemblage also is unusual in that it consists entirely of vessels imported from east Texas. At almost all of the other excavated Toyah sites, the ceramics are mostly or entirely Toyah-made wares.

In contrast, the Jayroe site contained a typically small assemblage of bone artifacts. The overall infrequency indicates that these kinds of artifacts were not critical to most activities performed at the sites, even though their widespread occurrence indicates they were a consistent part of what Toyah peoples did at various places across the landscape. This is particularly true for the awls and bone or shell beads/ornaments. The former may have been used in processing bison and deer hides or making basketry, and the latter indicate that personal adornment was widespread.

Several patterns are evident in terms of food acquisition. First, the scarcity of mussel shells at most sites indicates that shellfish were not a main food resource at most locations. Second, bison and deer were the main sources of protein at 41HM51 and almost all the other sites, with bison predominant at some sites and deer making a larger contribution at others, including Jayroe. Third, most sites have an array of smaller mammal remains (rabbits are common), birds, turtles, and fish, suggesting subsistence regimes that were at least somewhat diversified, although this is not the case at two sites where bison hunting and butchering were the main activities. Fourth, Toyah sites vary in terms of how broken up the animal bones are, and some analysts have suggested that intensive processing to produce bone grease was a feature of some sites. A fracture freshness index and fragmentation study of the Jayroe assemblage indicates that marrow extraction was more common than bone grease rendering there, however, and similar studies of two other sites reached similar conclusions. The excavated Toyah sites are not very informative about the use of plant foods, since plant remains tend to be sparse at best.

Comparisons in terms of procurement of other resources (e.g., firewood and raw materials for production of tools and construction of thermal features) are difficult because the topic is seldom addressed, but what is known indicates similarities from site to site. As at Jayroe, most of the wood charcoal indicates opportunistic collection of locally available fuel woods, and rocks used in thermal features were available locally at all sites. This was true for materials used to manufacture stone tools at almost all of the sites, with Jayroe being an exception, since cherts used to make most chipped stone tools probably came from source areas at least 25 km away. Presumably, this was still within the foraging range of the group who camped at 41HM51.

At some Toyah sites, features and other remains exhibit distributions that are consistent with the traditional hearth-centered household area camp model. Commonly, artifacts found near hearths seem to represent a redundant pattern of individuals or groups doing things that required similar tool sets rather than segregation of tasks into discrete activity areas. The Jayroe site does not conform well to this pattern, however, and instead appears to represent general camp activities performed in open space between or around household areas, with some areas of specific activities distinguishable. Jayroe looks different in this respect because the excavations were mostly in a part of the site between feature clusters, and perhaps because the occupation there was more discrete than those at most other sites. Jayroe is like the other sites in that the distributional evidence does not indicate consistent secondary refuse disposal peripheral to household areas. This supports the ideas that occupations were typically short and re-occupations were not frequent or planned in advance.

MOBILITY AND INTERACTION

The topics of mobility and interaction long have been important in Toyah archeology because they touch upon the broad issue of just what the Toyah phenomenon represents. Many researchers have explored these issues since Toyah was first defined in 1947, with much the debate focused on whether Toyah reflects the movement of specific peoples with a bison-centered subsistence strategy into central Texas from adjacent regions. A compelling interpretation offered by Nancy Kenmotsu and John Arnn is that many distinct groups characterized by high mobility and interaction occupied the Toyah area: “More specifically, there appears to be ample evidence that hunter-gatherers during the Toyah phase were not always small, kin-based groups whose mobility was restricted to a small portion of central Texas. Instead, these people were often described as large social aggregates composed of different groups, some speaking different languages, who traveled long distances. The formation of large, multicultural social aggregates…in central Texas may represent responses to social, political, and economic changes occurring outside of the region…as other groups carried those conflicts into the region during the early to mid-seventeenth century” (Kenmotsu and Arnn 2012:41). Arnn (2012b:68–69) goes on to call these groups and others “Tejas,” based on an account of the Hasinai Caddo in which Tejas referred to 50 or so named groups who were allies of the Hasinai: “Thus, there is little doubt that the region of the Tejas included central and south Texas and was a broad social field consisting of numerous distinct groups who were all allies.”

Figuring prominently in discussions of mobility and interaction is the common occurrence of artifacts from far-away sources in Toyah sites, particularly obsidian, marine shell artifacts or fragments, and nonlocal ceramics. Nonlocal ceramics are most frequent and widespread. Most are sherds from Caddo pots from east Texas, but small numbers of sherds might be Jornada Mogollon wares from far west Texas, Apachean/Puebloan wares from eastern New Mexico, wares local to the Rolling Plains of north Texas, and pottery from the Texas Gulf coast. Obsidian artifacts have been found at fewer sites, always in small numbers. Most are of material from the Jemez Mountains in north-central New Mexico, and single items are from southwest new Mexico, southeast Idaho, and northwest Wyoming. Marine shell ornaments and fragments have been found at a handful of sites. Presumably, most or all of these came from the Texas Gulf coast.

The three kinds of exotic artifacts tend not to occur together at the same sites, and this indicates that different mechanisms played roles in these items becoming part of the material culture of these groups. Participation in established exchange networks is a common explanation for their presence, and some relate these networks to efforts to buffer risk or cement long-distance alliances. But it appears that two distinct mechanisms were at work. One involved regular direct exchange for goods between Caddo groups and hunter-gatherer groups via maintained networks, perhaps most often in trade fair contexts along the eastern margin of the Toyah area. The other entailed occasional acquisition of finished items of obsidian, shell, and other materials from elsewhere, probably not associated with maintained networks. For obsidian at least, it is speculated that these items reached Toyah sites through person-to-person contact with groups from the southern High Plains.

A variety of other kinds of evidence potentially could contribute to addressing these topics, but analysis did not yield a fully satisfying result, in large part because data sets from the different sites have been analyzed and reported in dissimilar ways and excavations often were not large enough or placed in such a way as to provide a representative picture of what went on there. These problems aside, however, the data available are consistent with the idea that most Toyah occupations were of short duration, and this could have translated into high mobility overall.

The Jayroe site is unlike other excavated Toyah sites in that it alone yielded both obsidian and Caddo pottery, and, other than the remains of a single vessel from the Barton North site, it is the only one where only Caddo pottery was recovered. It is not clear that these differences are significant, however, and it and all the other sites present a picture of Toyah interaction and mobility that is consistent with the ideas of multigroup aggregation, long-distance movement, generally short-term occupations, and development of a Tejas social field. Evidence for this at Jayroe includes the following: the presence of a handful of artifacts from faraway sources, mainly east Texas; the absence of evidence for repeated, intensive occupation (i.e., no secondary discard or middens); the small size of the thermal features and limited labor invested in constructing them; the abundance of bones of bison and deer compared to those of lower-ranked animals; the fact that the wood used to fuel fires on the site likely came from nearby; and the presence of a tool kit consisting of certain specialized chipped stone tool forms but little in the way of ground and battered stone tools. Many other Toyah sites exhibit these same characteristics, and these are the things, along with the lack of cemeteries, that argue for a high level of long-distance mobility for Toyah peoples.

RE-EVALUATION OF THE RESEARCH DESIGN

This project was unusual in that the bridge construction schedule did not allow time to prepare a research design between testing and data recovery. In the end, there were no negative effects from this. The data recovery block was placed in a north-south segment of the site shown by testing to be productive, and its placement east-west was constrained by the right of way limits. In short, the block was placed where it logically had to be, and its size was based on consideration of how large an area could be excavated in a reasonable amount of time. A larger excavation, particularly east-west, could have provided more useful information, of course, but the boundaries of the right of way and disturbance from testing prevented this. The testing also demonstrated the association between the Toyah component and the paleosol, providing the justification for limiting the data recovery work to those deposits. This allowed the excavations to cover more area than would have been possible otherwise, and this certainly was a good thing. The best approach to data recovery, and its parameters, were evident to all parties involved (TxDOT-ENV, Prewitt and Associates, and the Texas Historical Commission), even absent a research design.

One issue unrelated to the research design that impacted the project was the extreme lag time between finishing fieldwork in July 2004 and wrapping up the analysis and reporting effort, which began in March 2017. The big down side of this was that the two key people involved in the fieldwork, principal investigator Karl Kibler and project archeologist Cory Broehm, were no longer employed by Prewitt and Associates by the time TxDOT-ENV issued the final work authorization (which, ironically, was just two days before Mr. Kibler's last day with the firm). That lack of continuity may have hurt the end product, since Mr. Kibler was no longer available to apply his many years of thinking about the site and Toyah archeology to it. There was an up side to the delay, however, in that it meant finishing the project happened after the flurry of productive research done on Toyah archeology by John Arnn, Nancy Kenmotsu, and others. This translated into a wealth of recently developed context for interpreting 41HM51.

The research design that ultimately guided completion of the project benefited from the fact that it was prepared after much of the preliminary analysis was done (i.e., radiocarbon dating, feature descriptions, analysis of lithic and ceramic artifacts, obsidian sourcing study, petrographic analysis and INAA of ceramic sherds, vertebrate and invertebrate faunal analyses, and macrobotanical analysis). The main thing that remained was to integrate the data to create an overall site interpretation. Hence, while the portion of the research design that TxDOT-ENV contributed was very focused on a particular question, the broader framework needed for the integrative effort was clear. This is not to say that all parts of it (and the various analyses that preceded its preparation) were equally successful, however.

Among the things that provided the most important information are the following: functional assessments of features based on morphology and contents and review of the literature on thermal features in central Texas; identification of stone raw material types and sources, including obsidian; analysis of debitage, cores, and tools to identify reduction strategies and manufacturing stages; analysis of tool fracture types, discard reasons, and resharpening/recycling to look at tool histories; analysis of the ceramics in terms of technology and origins, including INAA and petrography; full analysis of the vertebrate faunal assemblage, including the fragmentation and FFI study needed to address the TxDOT-ENV portion of the research design; full analysis of the macrobotanical assemblage; analysis of a large number of radiocarbon dates and careful evaluation of contexts and the materials dated to establish temporal parameters; detailed study of the vertical distributions of the archeological materials to decide how proveniences should be grouped for analysis; detailed study of horizontal distributions to explore what they convey about how the site was used and how to best interpret it; study of artifacts of exotic materials, review of models of socioeconomic networks, looking at distributional evidence for secondary refuse, and looking at faunal remains in terms of higher- versus lower-ranked resources to address mobility and interaction; and comparing the Jayroe site to other excavated sites to examine the bigger patterns of behavior that the Toyah phase represents.

Avenues of investigation that were notably less informative than hoped are as follows: identification of protein residues, particularly on stone tools; distributional studies to discern activity areas, which likely is a function of both the inability to discern very discrete occupations and the constrained placement of the excavations relative to the site as a whole; and using measures such as richness and evenness indices, anticipated mobility indices, and utility/mass ratios to explore mobility and interaction, which were hampered by lack of comparability between sites in terms of analytical schemes and component discreteness.

Although we were not able to eliminate the problems caused by the lack of comparability between sites (i.e., through reanalysis to fully assess integrity and make it possible to compare oranges-to-oranges), the information on 41HM51 and the intersite study presented here join the list of other recent significant contributions to Toyah archeology. By itself, the Jayroe site is not revelatory, but it constitutes an important data point for telling the overall story of the Toyah phenomenon.

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Part II

Review and Results of the TxDOT Research Design for the Jayroe Site (41HM51)

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CHAPTER 9: THE TXDOT RESEARCH DESIGN AND DATASETS UTILIZED TO ADDRESS THE HYPOTHESES

The archeological site designated 41HM51, also known as the Jayroe site, dates primarily to the Terminal Prehistoric Period (A.D. 1200–1750). The site is located approximately nine miles north of the community of Hamilton in Hamilton County, Texas, and is situated on the north bank of the Leon River. It was discovered in 2003 during efforts of the Texas Department of Transportation (TxDOT) to address environmental issues associated with a bridge replacement on County Road (CR) 294. The site was determined to be eligible for listing on the National Register of Historic Places (NRHP) under Criterion D (36 CFR 60.4): sites containing data likely to yield information important to the study of prehistory. Because it could not be avoided by the proposed bridge replacement project, the site was subject to data recovery excavations during the spring of 2004 by Prewitt and Associates, Inc. (Prewitt ; Permit nos. 3211 and 3405).).

TxDOT sponsored a series of feasibility studies in order to assess the quality and quantity of the data contained within the site. Those studies included cursory examinations of the ceramics, faunal remains, features, and lithics from 41HM51. In addition, since the radiocarbon assays dated most of the site to the Terminal Prehistoric Period and the site's location was in Central Texas, TxDOT recommended that Shafer's (2006) Prairie Caddo Model be considered during the interpretation of the site. The results of the feasibility studies turned out to be very informative. The faunal analysis revealed that a wide range of animals including deer and bison were consumed by the site occupants. It also revealed that a large quantity of the bone was broken into small pieces (Appendix A). The ceramic analysis confirmed that the pottery sherds recovered were from Caddoan vessels (Appendices B through E). Some sherds contained residue from food preparation (see Chapter 5 and Appendix H). The lithic analyses confirmed that the raw stone materials used to manufacture tools were primarily locally obtained (see Chapter 5 and Dockall 2014). The feature analyses confirmed the presence of multiple types of hearths and cooking features (see Chapter 5).

TxDOT continued to utilize Prewitt to conduct the reporting of the site, including the development of their own research design. Based upon the results of the feasibility studies and Prewitt's research design, TxDOT concluded that there were still important research avenues that the site data could be used to address, and these avenues warranted exploration, additional data analysis, and presentation. TxDOT proposed its own research design to augment Prewitt's work and to present that information. Thus, this report has two research designs contained within two parts of the same document.

The TxDOT research design proposed that the production of pemmican was a viable explanation for the formation of a substantial portion of the site remains (see Chapter 3). However, several analytical steps were required to build the foundation for a determination of the presence or absence of pemmican production in the prehistoric record, and its significance to the people who made it. In addition, researchers found that several issues are interrelated, such as questions about food production, the stability of foodstuffs for long-term storage, questions of subsistence versus socio-cultural uses of foods, overall mobility of communities, and cultural identity. The following five hypotheses attempt to address some of these questions, and are presented as true/false statements below:

1. The Toyah Phase site occupants engaged in bone grease extraction behavior.
2. Data related to bone grease extraction behavior is common in Toyah Phase archeological sites, but rare in Austin Phase sites.
3. The primary reason for the extraction of bone grease was to use it as a component in the production of pemmican.
4. The site's lithic assemblage suggests that the site's Toyah Phase occupants engaged in very limited migratory behavior.
5. The artifacts from the site's Toyah Phase can be used to test Shafer's Prairie Caddo Model.

Hypothesis 1 concerns the identification of bone grease processing in the archeological record, particularly at 41HM51. Hypothesis 2 also relates to bone grease but investigates the connection between bone grease extraction behavior and the cultural practices of the site inhabitants over time. Hypothesis 3 builds upon the first two hypotheses to determine whether pemmican was produced at the site. Hypothesis 4 is indirectly related to the production of pemmican and its significance to those who made it, and attempts to explore the relationship between a diverse lithic assemblage, which was found to be a factor in the production of bone grease and pemmican, and the overall mobility of the community inhabiting 41HM51 during the Terminal Prehistoric Period. The final hypothesis, Hypothesis 5, addresses the cultural identity of the site inhabitants, by exploring whether they were culturally affiliated with the Caddo.

In Chapter 8, under Summary and Conclusions, Prewitt concludes that by itself, the Jayroe site is not revelatory, and TxDOT disagrees with that conclusion. Based upon the implementation of this research design, the site has yielded information important to understanding the Terminal Prehistoric Period in Central Texas. Therefore, the results presented in this part of the Jayroe Site (41HM51) report support the determination that the site is eligible to the NRHP under Criterion D as outlined in Section 106 of the National Historic Preservation Act (NHPA).

THE IMPLEMENTATION OF THE TxDOT RESEARCH DESIGN

To assist in implementing the TxDOT research design, TxDOT utilized Katherine Seikel, Rachel Feit, and later, Tim Griffith and Mindy Bonine of AmaTerra Environmental, Inc. (AmaTerra). TxDOT also relied upon Jodi Jacobson, Ph.D., of Texas State University, San Marcos, who conducted an in-depth analysis of the site's faunal remains (see Appendix J). Additionally, Harry Shafer, Ph.D., agreed to discuss the comparison of his Prairie Caddo Model with the site assemblages; his work is presented in Chapter 14.

With the exception of the results of Shafer's comparison with his model, the results of the TxDOT research were generally successful in applying data contained within the site to the hypotheses. This should not be surprising because the hypotheses were developed based upon the information gleaned from the feasibility studies presented in Part 1 of this report. Therefore, conducting feasibility studies early on informs researchers of the actual data potential of the site deposits, and aids researchers in developing hypotheses that can be addressed by data from the site.

One item of note regarding the implementation of the TxDOT research design involves evidence of bone grease extraction behavior. Bone grease is a crucial ingredient in the production of pemmican and the extraction of grease is therefore an important activity underpinning the foundation of the TxDOT research design (see the following section). Despite the presence of a robust assemblage of small bone fragments, Prewitt concluded that bone grease extraction was not a significant activity occurring on the site (see Chapter 5). However, Prewitt utilized the Fracture Freshness Index (FFI) as defined by Outram (see Outram 1998, 2001, 2002a, 2002b) in their discussion of bone marrow versus bone grease exploitation even though Outram (2001, 2002a) specified that the FFI is not a reliable methodology to determine whether or not bone grease extraction was occurring. The results of the TxDOT study contradicted Prewitt's conclusion (see Chapter 10). The basis for TxDOT's conclusion involves Jacobson's faunal analysis of the bone fragments (Appendix J) and the parameters for identifying grease extraction developed by AmaTerra (see the following section). Notably, Jacobson determined that bone grease extraction was an activity occurring on the site (Appendix J).

Although Shafer concluded that the Prairie Caddo Model cannot be applied to the 41HM51 site deposits, Shafer's analysis provided additional information relevant to the Terminal Prehistoric Period in Central Texas. This information included the possibility that the Terminal Prehistoric occupation at site 41HM51 may have been mischaracterized as Toyah and that the site could be affiliated with Caddo or Caddo associated groups. The major factor in this determination is the Caddoan ceramic sherds which comprised the entirety of the ceramic assemblage.

Shafer's analysis supports the overall TxDOT hypothesis that mobile bands of Terminal Prehistoric peoples may have adapted to the harsher winters and shorter growing seasons associated with the Little Ice Age (A.D. 1300–1850). This climatic shift may have forced sedentary or semi-sedentary peoples with an agrarian lifestyle to adopt a mobile hunting and gathering strategies to diversify their diets to survive. The occupants at the Jayroe Site in the Terminal Prehistoric Period subsisted on a large variety of small to large game animals while they hunted and processed bison and deer, potentially to produce pemmican in addition to other foodstuffs to survive the long, harsh winters.

The potential utilization of bone grease for use in pemmican is a significant feature of TxDOT's research design, being incorporated in some way in three of the five hypotheses. As such, AmaTerra conducted thorough research into bone grease exploitation, pemmican production, and archeological studies conducted within Central Texas and the Plains to address Hypotheses 1 through 3 of TxDOT's research design. The background material compiled and utilized to test Hypotheses 1 through 3 are presented in the following sections to ensure coherent presentation of material referenced in Chapters 10 through 12.

BONE GREASE EXTRACTION AND ITS IDENTIFICATION IN THE ARCHEOLOGICAL RECORD

Indigenous hunter gatherers in North America utilized fats and oils rendered from smashing and boiling faunal bone in foodstuffs and numerous other applications (Colpitts 2015; Reeves 1990). Ethnohistoric accounts document a wide range of uses for bone grease including in pemmican, stews and other foodstuffs, as sealant for hide bags and wood objects, to process hides for shelter and clothing, to produce grease paints, to oil bows and bowstrings, and to straighten arrow shafts. However, in the archeological literature, hunter-gatherer bone grease extraction is most often interpreted solely as a subsistence practice. Archeologists often focus on grease processing remains and features as an adaptive strategy to marginal environments (e.g. Binford 1978), even though there is overwhelming ethnographic evidence demonstrating grease was utilized for a wide range of purposes beyond subsistence. In fact, the process of rendering grease from animal bones was part of a general provisioning that served practical, aesthetic, ceremonial and spiritual needs of native groups just commonly as subsistence needs. This section reviews the results of archival research into bone grease processing, grease utilization, pemmican production, and archeological studies with implications for interpreting grease production within sites, and outlines criteria which may be applied to identify instances of grease extraction, and possibly pemmican production, within the archeological record.

BONE GREASE VERSUS BONE MARROW

There are two types of fat stored in the bones of vertebrate fauna: grease and marrow. Bone marrow is defined as the dense gelatinous or solid fat contained within the hollow cavities within bones, particularly the medullary cavity of long bones. Bone grease, on the other hand, refers to the fats that are stored within the cancellous tissue of the flat bones and the epiphyses of major long bones (Baker 2009; Outram 2001; Sunseri 2015). Methods for accessing and extracting bone grease and bone marrow leave similar signatures in the archeological record, however, they are significantly different in practice.

Bone marrow can be obtained by splitting open the bones and scraping it out with fingers or tools. It could also be sucked out for immediate consumption, even when raw. Marrow may have been used in cooking; however, it was often consumed immediately because the unprocessed fat in bone marrow was an important source of concentrated fats. Ethnographic and enthnohistoric accounts note that marrow was considered a delicacy by some peoples in the past.

Bone grease extraction requires additional processing. Bone grease can be extracted from bones after the bone marrow has been removed. Bone marrow extraction should be considered the first step in bone grease extraction (see Appendix J). Since the cancellous bone tissue encapsulates bone grease, extracting it requires boiling in hot water for the grease to liquefy and separate from the bone structure. The grease from the bone becomes suspended in the boiling water and can be skimmed from the surface of the water after it cools, and the grease solidifies. It is possible that some bone grease was immediately consumed as a broth or soup while it was still hot. However, ethnographic research (see below) reveals that bone grease was used for multiple purposes and its extraction for immediate consumption was not usually the goal of most bone fragment boiling.

Unlike bone marrow, grease may have been perceived as a more utilitarian ingredient in cooking and other tasks.

A clear explanation of the distinctions between bone marrow extraction and bone grease extraction is important at this juncture to elucidate the difference between the two closely related behaviors. The subtle distinctions between bone marrow extraction and bone grease extraction are not well understood by some researchers. This is apparent in the Paleo Research Institute Report where they identify the animal lipid protein residue on pottery sherds solely as bone marrow, without documenting consideration of bone grease (Appendix H:6-9).

ETHNOHISTORIC AND ETHNOGRAPHIC DOCUMENTATION OF BONE GREASE EXTRACTION AND USE

Ethnohistoric and ethnographic accounts of native North American hunter-gatherers and horticulturalists offer a great deal of detail about the extraction and use of bone grease. In prehistoric North America, bone grease was extracted via stone boiling of bone fragments in rawhide sacks, sacks made of animal stomachs, other containers, or by lining an earthen pit with animal skins or stomachs. Once pottery and metal kettles were introduced, direct boiling occurred using pots placed over an open fire. Methods utilized for bone grease extraction regardless of time period were typified by boiling fragments of long bones and crushed epiphyses. Once the grease rose to the surface of the water, it was skimmed off into a storage container or were mixed into foodstuffs. Typically, ungulate bones were utilized most often, though bear, rabbit and fish bone were used by some groups. The Caddo commonly used grease extracted from bear meat and bones, while the tribes of the northwest frequently used fish to produce grease for pemmican and other foods (Holzkamm et al. 1988; Swanton 1942). There is also evidence that in cases of extreme scarcity some native groups would scavenge the plains for bones which might still contain fat reserves which could be accessed through boiling (Kneale 1950).

The most commonly discussed use of bone grease in the literature is as a component in foodstuffs. Grease was mixed into soups, stews, salads, pemmican, and other foodstuffs (Buskirk 1986; Emmons and De Laguna 1991; Gelo 2006; Hungry Wolf 1980; Kennedy and Stevens 1972; Murie and Parks 1989; Swanton 1942). Pemmican production was one of the most commonly discussed dietary uses of bone grease in hunter-gatherer groups and was similar across the cultural groups reviewed. Pemmican was a staple that allowed many hunter-gatherer groups to last through harsh winters, but it was also used as a feast and/or ceremonial food, a foodstuff shared with visitors, and a portable food that did not require cooking while traveling or out on raids (Cooper and Flannery 1957; Gelo 2006; Long et al. 1961; Schultz 1980; Wildschut and Ewers 1960). The base ingredients of pemmican were pulverized dried meat and bone grease. The type of meat used varied depending on availability and geography, but included bison, deer and elk in many locations. Pemmican recipes varied based on the group in question, available edible resources, and the intended use of the pemmican. Some indigenous groups who depended heavily on fisheries would make a type of pemmican from flakes of dried fish mixed with fish oil and/or bone grease (Holzkamm et al. 1988; Smith 1982). Ingredients that were often added to pemmican include dried and mashed fruits, berries, nuts and seeds. In some cases, usually ceremonial, medicinal or aromatic herbs were mixed in.

Once produced, pemmican was packed into intestines, parfleches or similar containers while still hot, and then was tamped down to remove excess air (Forde 1950; Grinnell 1962; Schultz and Donaldson 1930). Storage containers were traditionally sealed with grease or tallow to assist in the long-term preservation of their contents. It has been hypothesized that bone grease could preserve for up to three years, if properly stored (Sunseri 2015). Some groups buried pemmican stores in stone-lined pits in the ground (Forde 1950).

Grease rendered from crushed bone had a much wider range of uses in addition to foodstuffs, and its production was nearly ubiquitous among indigenous hunter gatherers (and common among horticultural groups) in North America. Additional uses for bone grease include waterproofing for hides, as sunscreen and/or protection against chapped skin (when mixed with specific clays or pigment), as an insect repellant, as a means to remove face or body paint, as sealant for food storage containers, and for maintaining bows and arrows (Denig and Hewitt 1930; Morgan 1959; Smith 1974; Swanton 1942, 1946; Wallace and Hoebel 1952). The diverse uses of bone grease amongst North American tribes should not be underestimated in the archeological record.

Notably, bone grease was frequently mixed with charcoal, ochre, clays, and other pigment minerals for a variety of purposes. Narratives document that the Assiniboine, Crow, and Blackfoot, amongst other groups, mixed grease and charcoal to make body paint (Morgan 1959; Wissler 1910). They also mixed grease with ochre for paint applied to ritual skull medicine bundles and rattle sticks (Wildschut and Ewers 1960), to decorate hides, and paint lodge walls (Denig and Hewitt 1930). Additionally, the Caddo around the Red and Sabine Rivers painted their faces with a mixture of bear grease and ochre for aesthetic purposes (Swanton 1942). They also burned bear or buffalo tallow as an offering to the gods before going to war (Swanton 1942).

CRITERIA FOR IDENTIFYING BONE GREASE EXTRACTION

Identifying archeological signatures of bone grease extraction may be difficult, since it likely occurred in multi-purpose cooking facilities which may have been subject to reconfiguration and reuse (Prince 2007:17; Vehik 1977:172–173). It is further complicated by the handling of cooking refuse and debris, which may not be deposited in association with cooking features within a site. This section synthesizes information from ethnohistoric and ethnographic accounts and results of taphonomic studies to posit what archeological evidence for bone grease extraction might include. The criteria developed for the identification of sites where bone grease extraction potentially took place are then utilized to address aspects of Hypotheses 1 through 3.

In a study of bone grease extraction in archeological sites in Wisconsin, Baker (2009) outlined four criteria for the identification of bone grease extraction in faunal assemblages. These criteria include faunal fragment size, determination of agent of fracture, the taphonomic history of the assemblage, and the context of the faunal assemblage (Baker 2009:12). These criteria are based around faunal assemblages, but the taphonomic history and context criteria can be expanded to include the site as a whole. Each criterion and their affiliated material markers will be discussed in more detail below.

BONE AND BONE FRAGMENT SIZE

Ethnographic and historic records indicate that bison, deer, pronghorn and elk were preferentially taken by many indigenous groups in North America, though indigenous groups also relied on other game based on availability. A review of faunal data from numerous archeological sites in Central Texas is consistent with historic observations. Smaller taxa typically associated with these sites include rabbits, turtle, fish, rodents, canids, mussels, and, in some cases, fish. The processing of fauna varies based on their size. First, large game such as bison was likely processed differently than deer-sized or other prey based on the concept of transportation utility (Lyman 1995; Madrigal and Holt 2002:746). If the entire carcass was not transportable to the camp or village, the animal would be partially processed at the kill site and only the most desirable elements and meat would be transported. Differential processing of prey along this model would result in differential disposal of elements based on element utilization and processing techniques (Madrigal and Holt 2002:756). A second consideration is the potential for grease utilization in certain taxa. In addition to being preferred based on quantity of meat per animal, larger animals would have provided larger quantities of marrow and grease per animal as well. As such, it is probable that evidence for bone grease extraction would be more common in faunal assemblages which include medium to large mammals.

Experimental studies determined that long bones contain the largest amounts of marrow and grease, which is the reason why humans and other carnivores preferentially utilize the same skeletal elements (Brink 1997:263, 270). Studies also show that boiling smaller bone fragments (5 cm in size or smaller) is more efficient than boiling larger fragments (Church and Lyman 2003; Janzen et al. 2014). Church and Lyman (2003) examined the optimal bone fragment size for rate of grease return, and Janzen and colleagues (2014) determined that boiling of smaller fragments required less investment in water and fuel to extract the grease. "Bone fragmentation materially may reflect time and effort trade-offs by knowledgeable actors, aimed at maximizing grease benefits while minimizing water and fuel costs" (Janzen et al. 2014:523). Faunal assemblages which may indicate processing for bone grease would have a greater intensity of fragmentation (i.e. high NISP/MNE ratios), small specimen sizes, and evidence for crushing of epiphyses (Lyman 1995:242; Outram 2001:402; Sunseri 2015:278). Faunal remains or midden deposits which meet these requirements have potential to be associated with processing for bone grease extraction.

AGENT OF FRACTURE

A consideration regarding faunal remains is that bone breakage patterns in long bones typically utilized for grease extraction must be examined carefully in order to distinguish between breakage for grease or marrow extraction, breakage for tool production, carnivore scavenging, and other taphonomic processes (Brink 1997:272; Karr 2015; Madrigal and Holt 2002:756). The utility of bone for grease extraction and tool production are both optimal when bone is fresh or minimally degraded (Karr 2015; Karr and Outram 2012) but crushing of epiphyses is not typically associated with bone tool production. Evidence of scavenging by carnivores is more complex, since scavengers target the same elements as those preferred for grease extraction. The taphonomic signatures of scavenging and bone grease extraction appear to be similar because they serve the same ultimate goal, but carnivores leave tooth marks which should be distinguishable from percussion marks from stone tools.

SITE TAPHONOMY

Post-depositional processes play a significant role in whether grease extraction is evident in a faunal assemblage. Examples of taphonomic processes which may impact sites in central Texas include trampling by herd animals, the redeposition of materials during flood events, rock-falls in rock shelter sites, and post-depositional scavenging or bioturbation. These processes have the potential to mask evidence for or against bone grease processing within archeological sites, since portions of the overall assemblage can be washed away or further impacted. In the case of post-depositional breakage, there should be a difference in the shape of the break depending on whether the break occurred around or prior to the time of deposit, or post-deposition. However, this may be complicated in the case of bone grease extraction since boiled bone loses its elasticity and may become brittle (see Appendix J).

Identifying taphonomic processes which impacted an archeological site is important to determining whether there is mixing of occupation layers, identifying disturbed areas, accounting for preservation issues and/or breakage patterns in the artifact assemblage, and understanding if and how the landscape around the site may have changed over time. Site taphonomy provides the foundation for building a context for the site.

CONTEXT AND ARTIFACTS

The context in which artifacts and food remains are recovered provide valuable information about the occupation of the site and cultural practices. Contexts in which bone grease extraction occurs can be difficult to identify solely based on the faunal assemblage due to taphonomic issues already discussed. In order to build a well-founded interpretation of bone grease extraction the broader site context must be considered. Things to look for would include cooking, boiling pit or hearth features, thermally altered stone, a diverse lithic tool assemblage which includes hammerstones and/or groundstone artifacts, ceramics in some cases, and evidence for other materials which may have been used with bone grease such as pigment stone or ochre for grease paint production. Additionally, macrobotanical remains of fruit seeds or nuts that may have been used in the production of pemmican may form another line of evidence when paired with significant indicators of bone grease processing.

Ethnographic and ethnohistoric accounts of grease extraction make no mention of specified areas or facilities, so evidence should be present in relation to generalized cooking features and food processing areas. Identification of cooking features associated with bone boiling may not be a straightforward process. Speth (2015) argues that direct boiling was possible without ceramic technology, which is supported by the use of hide bags for boiling (with or without stones) in the ethnographic record. An additional issue which complicates identification of sites in which bone grease was extracted is that the presence of thermally altered rocks is not a signifier of any specific cooking technique, and only demonstrates that stones were used (Speth 2015:56). Identifying cooking facilities which may have been used for bone boiling for grease extraction may rely on supporting evidence from other materials present at the site.

The most reliable evidence for bone boiling in sites with associated ceramics may be found through residue analysis of ceramics. Evidence for boiling of bone and other foods is most likely found on the neck or shoulder of ceramics (Malainey et al. 1999:427). Lipid residues recovered from ceramics can provide signatures for various protein sources (e.g. fish, bison, etc.) which are distinct from bone marrow signatures (Malainey et al. 1999). Residue analysis on groundstone, hammerstones or thermally altered rock would also be potentially valuable as a means of providing supporting evidence of grease extraction (see Appendix H).

Other features or artifacts associated with bone grease extraction include dark-stained 'greasy' soils (Karbula et al. 2001), caches used to store foodstuffs (e.g. Forde 1950), and containers (ceramic, hide or wood) used to store the grease after it was extracted (e.g. Gelo 2006; Miller and Beierle 2002; Wissler 1910). Unfortunately, samples of stained soils are not always taken, and samples may not be analyzed for lipid residues. Another issue to consider regarding caches or storage is that caches may not be located close to the site center to avoid attracting scavengers into camp, and storage containers may not preserve in many site contexts. Although the recovery of these features or artifacts would provide supporting evidence of grease extraction and utilization, we did not include them in the suite of features and artifacts examined in this study to identify sites with potential evidence for bone grease extraction.

ARCHEOLOGICAL INDICATORS OF GREASE EXTRACTION

Based on a review of ethnographic and ethnohistoric accounts, and experimental and taphonomic studies, archeological features and artifacts that may be used to determine whether bone grease extraction was a likely activity in a given archeological site include 1) hearths or other cooking facilities, 2) fire-cracked or thermally-altered rock, 3) a faunal assemblage containing medium to large-sized animal remains and with high frequencies of small indeterminate mammal bone fragments, 4) a diverse lithic tool assemblage, 5) hammerstones, 6) groundstone, and 7) pigment stone and/or ochre. This last item (ochre) is consistently overlooked in archeological discussions of bone grease processing, which focus almost exclusively on the activity as part of subsistence practices. That bone grease was commonly mixed with ochre and other pigments for grease paint is not a new discovery; however, the practice is rarely addressed even in ochre-rich assemblages that also exhibit other markers of bone grease processing. Finally, 8) lipid residues with signatures consistent with marrow or bone fat recovered from ceramics or stone tools are considered to be supporting evidence for grease extraction.

Items from this list above form a suite of evidence, which, when examined as a group, provide potential indicators of bone grease extraction within archeological contexts. If four or more indicators appear within a site and post-depositional processes cannot account for the majority of faunal breakage patterns, bone grease is considered a likely activity which took place at the site. In the following three chapters these criteria will be applied to archeological sites in Central Texas, including 41HM51, to determine if bone grease extraction and pemmican production were activities which occurred at the examined sites.

CHAPTER 10: HYPOTHESIS 1: THE 41HM51 TOYAH (TERMINAL PREHISTORIC) SITE OCCUPANTS ENGAGED IN BONE GREASE EXTRACTION BEHAVIOR

This chapter explores the first hypothesis presented in the TxDOT research design: that the 41HM51 Terminal Prehistoric Phase site occupants engaged in the production of bone grease. This chapter utilizes the criteria presented in Chapter 9 for the identification of grease extraction in archeological sites. These criteria build upon a framework of ethnographic, ethnohistoric and archeological studies pertinent to bone grease processing, taphonomic processes, and other factors which may contribute to or impact interpretations of bone grease processing in the archeological record. The criteria identified as indicators of grease processing are applied to the 41HM51 assemblage to assess whether grease processing was occurring at the site and to better understand the range of activities and interactions that may have occurred at this location during the Terminal Prehistoric Phase.

ANALYSIS OF MATERIALS FROM THE JAYROE SITE (41HM51)

The Jayroe Site, 41HM51, is a Late Archaic and Terminal Prehistoric site with occupations dating primarily between A.D. 1220 and 1700. A total of 18 features were identified in the testing and data recovery excavations. Twelve of these date to the Terminal Prehistoric/Toyah component of the site, four were assigned to the Late Archaic component, and two were determined to be non-cultural. Features identified at 41HM51 include discard piles (n=4), burned rock concentrations (n=3), cooking features/hearths (n=5), faunal bone and shell concentrations (n=3), and a flint knapping activity area. The range and quantity of features reflect an occupation site with several closely-spaced occupations from the Terminal Prehistoric overprinting a Late Archaic occupation. Features from the Terminal Prehistoric component of the Jayroe Site generally suggest activities which could be related to bone grease processing, in addition to other activities.

SITE 41HM51 FAUNAL ANALYSES

There have been three faunal analyses conducted on the site assemblage. The first was conducted by Mike Quigg in 2014. It was performed as part of the feasibility studies sponsored by TxDOT in an effort to ascertain the quality and quantity of data within the site's faunal assemblage. A large part of the TxDOT research design was based upon his findings. Those findings included the conclusion that the preponderance of highly fragmented bone was due to bone grease extraction (see Appendix A).

The second analysis was conducted by Prewitt. A detailed explanation of this study is documented in Chapter 5 of this report. It in part addressed the TxDOT research question investigating the validity of Outram's FFI. It also involved a bone size grade analysis. Chapter 5 provides a detailed explanation of the theory and methods associated with the Outram model. Prewitt's application of Outram's model to a sample of the site's faunal assemblage resulted in the observation that the bone fragments from the site did not fit Outram's criteria for bone grease extraction. The overall texture of the bone fragments appeared aged and weathered and the angles of fracture patterns appeared to occur on old and not fresh bone. Prewitt therefore concluded that the preponderance of small bone fragments observed on the site was not due to bone grease extraction. Prewitt instead concluded that the bone fragments were due to bone marrow extraction and subsequent weathering, erosion, and trampling. However, the application of the FFI to the examination of bone grease extraction was inappropriate, since Outram (2001, 2002a) notes that the FFI cannot be used as a predictive methodology in terms of bone grease extraction.

A third analysis was conducted to resolve the discrepancies between the results of the first two analyses. The third analysis was conducted by Jodi Jacobson, Ph.D., from Texas State University, San Marcos. This study was the most comprehensive of all three analyses. Not only does it address the conclusions from the previous analyses, but it also analyzed the entire faunal assemblage. She concluded that there are issues with the Prewitt faunal analyses and related results, which are detailed in Appendix J. She also concluded that bone grease extraction was an important activity occurring on the site. Jacobson's analyses determined that the faunal collection is highly fragmentary (83 percent of the bone was 3 centimeters or less in size), and display characteristics indicative of both marrow extraction and bone grease processing. She also noted that freshly broken bone fragments become degraded and brittle during the boiling process (see Appendix J). The resulting bone fragments are easy to break and appear weathered, which is the reason the FFI cannot be reliably applied to bone grease extraction (Outram 2001, 2002a). The wear on such fragments could be mistaken for the wear that occurs from being exposed to the elements, scavenged by animals, and trampled (Appendix J), which contradicts the conclusion from the Prewitt analysis.

Additionally, the other basis for Prewitt's conclusion that bone grease extraction was not an activity occurring on the site involves bone size grade analysis. This compares the total weight of various sizes of bone fragments from a sample of the faunal remains. This analysis resulted in Prewitt observing that the cumulative weight of large bone pieces outweighs the cumulative weight of smaller bones. However, the presence of large bone fragments or complete epiphyses that have not been further processed does not necessarily mean that bone grease extraction was not an activity occurring on the site. There are multiple reasons why some bones would not be processed for grease extraction and their presence could skew the results. These include the site occupants recognizing that poor quality marrow would result in a grease yield that would not be worth the effort. Animals that were emaciated due to age, starvation, pregnancy, disease, or for some other reasons, would not have their bones processed for grease extraction. These specimens would demonstrate poor marrow yields and the knowledgeable site occupants would know that it would be futile to attempt to obtain bone grease from the animal (Appendix J). In addition, it is possible that bone grease extraction was not an activity that was performed in each of the numerous occupations of varying lengths at the site.

Jacobson's analyses indicate that the faunal remains at Site 41HM51 demonstrated clear taphonomic degradation in the form of post-depositional breakage, rodent gnawing, and other variables (see Appendix J). However, Jacobson also found that the assemblage exhibits characteristics that are consistent with marrow and bone grease extraction. She argues that Features 11 and 13 particularly demonstrate clear signs of marrow extraction, based on spiral fracturing patterns, percussion impacts or and cut marks. These two features are characterized as a discrete bone cluster (Feature 11) and a rock cluster interpreted as a possible hearth rake-out pile (Feature 13). Spatially they are quite close to each other which may support the idea that this area was a center of initial processing and cooking.

The Texas State faunal analysis (Appendix J) also argues that bone grease processing may have occurred in and around Features 8 and 9. These two features are also adjacent to one another in a different location of the site than Features 11 and 13. Feature 8 is characterized as an irregular basin of burned rocks with particularly dense charcoal deposit around its perimeter. The feature was lying on a band of charcoal and ash and burned clay suggesting an intact thermal feature (see Chapter 5). A ceramic sherd was also found in context with the feature. Flotation of matrix from this feature yielded a large amount of micro-debitage, small bone fragments, hickory nuts and a charred tuber of Indian Breadroot. Feature 9 is a 55-centimeter wide pit feature containing no burned rocks with burned clay throughout and charcoal along the bottom edge. According to Jacobson, the Feature 8 faunal assemblage in particular exhibits all the hallmarks of bone grease processing which includes small fragments, burned fragments with many fracture types, crushed epiphyses, and a variety of taxa (Appendix J). The fact that Feature 8 is adjacent to a rockless pit does suggest that perhaps stone boiling to render grease may have been an activity occurring at these two features. Jacobson concluded that bone grease extraction was an activity that was occurring on the site (Appendix J).

BONE GREASE AND THE NON-FAUNAL ARTIFACT ASSEMBLAGE FROM 41HM51

Approximately 7,000 stone artifacts were recovered from the Jayroe Site, the majority of which are lithic debris. In addition to lithic debris, there are lithic tools, ground and/or battered stones, ochre and prehistoric ceramics (representing 3 vessels). The lithic tool assemblage included unifaces (including 17 scrapers), drills, perforators, a graver, a hand axe, bifacial knives, ovate and other bifaces, two dart points, and more than 80 arrow points or arrow point fragments. The hand-axe was recovered from Unit 107 near a freshwater mussel shell concentration which included 96 small bone fragments in the feature fill. Approximately half of the bone fragments exhibited green breaks, which could have been created by several tools including a stone hand-axe. The groundstone artifacts included eight hammer stones, an anvil fragment, four slabs, three manos, a polishing/burnishing stone, and two indeterminate groundstone fragments. Ceramics from the Jayroe Site were of Caddo manufacture. There were seven obsidian artifacts that originated from the Jemez Mountains of New Mexico, which likely represent long-distance trade and contact between indigenous groups. The diverse lithic tool and groundstone assemblages would been utilized for a range of site activities including hunting, butchery, food preparation, bone grease rendering, and hide processing. More specifically, they represent the type of diverse artifact assemblage that would be expected at sites where grease processing was taking place in addition to other activities.

Of note, there are 38 pigment stones, mostly identified as hematite or ochre, recorded at the Jayroe Site. Of these, one was a blue pigment stone of undetermined mineral composition. Three pieces of ochre exhibited clear evidence of smoothing and/or striations, suggesting they were used for pigment. One was affixed to a groundstone slab fragment, which was discovered in association with Feature 11, where bone breakage for marrow likely occurred. The presence of these pigment stones in association with faunal remains and cooking and grinding features supports the interpretation that they were being mixed with grease and/or marrow for use in paints, dyes, and possibly medicines.

RESIDUE ANALYSIS

The results of the organic residue analyses conducted by Linda Scott Cummings (see Appendix H) also indicate of a wide range of subsistence practices which may include grease rendering and pemmican production. Residue analysis was conducted on seven of the 43 ceramic sherds recovered from site 41HM51, five groundstone artifacts, and nine chipped stone tools. Residue analysis focused on the identification of organic residues, primarily proteins, when present on the selected artifacts. No residues were present on seven of the chipped stone tools. However, plant carbohydrate residues and/or lipid residues from meat or animal fat were present on all the ceramics, the groundstone, and two of the lithic tools. The lithic tools included a chopper and a biface. Residues identified included lipids from bison, rabbit, eels, and possibly other land mammals, and plant carbohydrates. Residue on the ceramics suggests the cooking of carbohydrate rich plants and animal fats (only marrow was specifically mentioned). Groundstone artifacts also exhibited plant and animal residues, suggesting the use of groundstone artifacts for processing both floral and faunal foodstuffs. The presence of pectins among the various polysaccharides on a metate fragment suggests fruit processing for use in foodstuffs, possibly pemmican.

SUMMARY AND CONCLUSIONS

Hypothesis 1 has been supported by the evidence presented in this chapter using the criteria for identifying bone grease processing presented in Chapter 9. Two qualified faunal analysts concluded that bone grease extraction was an important activity occurring on the site. Their conclusions were based largely in part on the robust assemblage of bone fragments measuring five centimeters or less in length. Overall, archeological evidence from the Jayroe Site, 41HM51, is consistent with the parameters for identifying sites where bone grease extraction was occurring (see Chapter 9). The site exhibits a range of cooking and discard features, a diverse lithic and groundstone tool assemblage, a large faunal assemblage comprised of highly fragmented faunal remains that exhibit markers of bone grease and marrow extraction, ochre, and cooking/food processing residues on ceramics and other tools. Moreover, the presence of ochre and tools which may have been used to process hides suggest a wide range of activities at the site apart from simple subsistence. The features, artifacts and data analysis all suggest that bone grease processing was occurring as a part of a larger course of provisioning that probably included a range of dietary and socio-cultural needs. This study concluded that the 41HM51 Terminal Prehistoric Phase site occupants did engage in the production of bone grease.

CHAPTER 11: HYPOTHESIS 2: DATA RELATED TO BONE GREASE EXTRACTION BEHAVIOR IS COMMON IN TOYAH PHASE ARCHEOLOGICAL SITES, BUT RARE IN AUSTIN PHASE SITES

While investigating the Flatrock Road Site, 41KM69, in Kimble County, researchers reported that bone fragment frequency appeared to decrease during the Austin Phase but increased dramatically during the Toyah Phase (Thompson et al. 2012:129). High degrees of bone fragmentation are commonly associated with bone grease extraction (see Chapter 9). Chapter 10 established that bone grease extraction was occurring at 41HM51 with supporting evidence presented in Appendix J. Since site 41HM51 primarily dates to the Toyah Phase, it was determined that Hypothesis 2 may have implications for the interpretation of the site and should be further examined. Hypothesis 2 states that bone grease extraction was a more common activity in Toyah Phase site components versus Austin Phase sites components.

Texas archeologists generally date the Late Prehistoric Period in Central Texas from A.D. 700 to 1750. Earlier prehistoric cultural manifestations, including the Paleoindian through the Archaic Periods, are beyond the scope of this investigation, and will not be discussed in detail below. For further reference concerning these earlier periods, Collins (2004:101–126), provides a detailed discussion about the entire prehistory of Central Texas, which is the baseline resource for the study of prehistory in this region. Archeologists have divided the study of the Late Prehistoric Period into two phases. These are the earlier Austin Phase and the later Toyah Phase. The cultural manifestations defined as the Austin Phase have been dated from A.D. 700 to 1300. The Toyah Phase cultural components have been dated from A.D. 1300 to 1750. Most of the cultural manifestations in Central Texas, including both the Austin and Toyah Phases, appear to have been associated with the hunting and gathering subsistence strategies since evidence of agriculture is rare.

Currently, there is debate within the archeological community regarding the connection between the Austin and Toyah Phases (Collins 2004:123). Did the Toyah Phase develop from the earlier Austin Phase, or is the Toyah Phase best explained as a migration of outsiders into Central Texas? If bone grease extraction behavior intensity remained stable during both the Austin and Toyah Phases, then the argument for cultural continuity could be strengthened. If, however, the intensity differs significantly between the two, then the argument for the opposite is supported. Any evidence, or lack thereof, for cultural continuity would assist in resolving the debate and therefore add to our understanding of the Late Prehistoric Period in Central Texas. The examination of Hypothesis 2 may result in the identification of information relevant to the ongoing discussion regarding cultural continuity in the Late Prehistoric in Central Texas.

THE AUSTIN PHASE (A.D. 700–1200)

The most obvious observation that separates the Austin Phase from the earlier Archaic Phase is the transition from the use of atlatls (spear throwing sticks) to the use of the bow and arrow (Collins 2004: 123; Hixson n.d.). This transition indicates a significant technological change in hunting practices, and by extension, some cultural practices may have also changed from their Archaic past. Archeologically, this transition has been identified by the presence of small, distinctive, stone projectile points with notches that facilitated hafting to arrow shafts. These include Alba, Bonham, Catahoula, Cuney, Edwards, Sabinal, Scallorn, and Steiner types. Scallorn is the most common and therefore considered as the definitive type for the Austin Phase.

Other than the adoption of the bow and arrow, the Austin Phase appears to be a continuation of the subsistence practices typical of the preceding Late Archaic Period. This includes the reuse of burned rock ovens creating large discard middens, and the reoccupation of campsites with earlier Archaic Period components. Exploitation of a wide array of plants and animals was also a hallmark of the Austin Phase that is also a general continuation of the preceding Archaic Period lifeways. Bison remains as well as pottery appear to be rare in the archeological record dating to this time (Thompson et al. 2012:21). Interestingly, cemeteries have been discovered with more than a few instances of violent death observed (ibid).

The Austin Phase climate appears to have been xeric (hot and dry) and associated with the Medieval Warm Period also known as the Little Climatic Optimum that occurred from A.D. 900 to 1300 (Rafferty n.d.). This climatic anomaly likely produced hot, dry summers and very mild winters. Bison herds were likely concentrated in the northern plains where winter snow gave way to lush summer grasses. The Medieval Warm Period likely also increased agricultural productivity and crop diversity in the fertile agricultural areas located on the peripheries of Texas (see Chapter 14). It would have stabilized and extended the growing seasons and spawned a florescence of agriculture. This warm period may have been a windfall for agrarians on the margins of Texas. However, it likely produced hot and dry conditions in Central Texas, encouraging the population to leave the region and/or concentrate occupations around reliable sources of water. This would help explain the relative scarcity and geographic patterning of cultural materials dating from the Austin Phase.

THE TOYAH PHASE (A.D. 1200 TO 1750)

Toyah material culture includes small arrow points made from flakes (e.g. Perdiz and Harrell), beveled knives, bone-tempered clay pots, and an abundance of flake tools, end scrapers, and perforators made from flakes rather than through bifacial reduction. Stone tools from the Toyah were typically made from local cherts. Toyah sites can often demonstrate distinctive activity areas, evidence of structures, and hide processing (Kenmotsu and Boyd 2012). Although initial formulations of the Toyah Phase suggested that bison were a major focus of the subsistence regime, more recent studies have demonstrated more varied food procurement that relied on a wide variety of mammals such as deer, antelope, rabbits, and rodents, in addition to turtles, birds and other aquatic species. Evidence for plant gathering and use has been found in the charred remains of onions, persimmon seeds, mulberry wood, nuts and other botanicals. There appear to be more Toyah occupations relative to the previous Austin Phase in Central Texas. More details regarding Toyah Phase material indicators have been provided in Chapter 3

Toyah Phase climate appears to have been much more mesic (wet and cold) than the preceding Austin Phase, and has been referred to as the Little Ice Age (A.D. 1300–1850). This climatic anomaly produced shorter, cooler, summers and longer, harsher winters (Mann 2002:504–509). The agrarians living on the periphery of Texas likely were subject to shorter and unpredictable growing seasons. The grass covered areas on the northern plains were likely snow covered for longer periods of the year pushing bison herds further south and into Central Texas. These climatic changes, which impacted the bison ranges, may have caused a shift in subsistence strategies which were more heavily reliant on hunting and gathering. This change would also be apparent in group mobility patterns with an increase in short-term campsites and fewer permanent habitation sites. This increase in mobility across Texas and other regions in North America may have increased intergroup contact while possibly limiting the size of individual group ranges providing opportunities for intergroup trade and conflict (e.g. Ray 1984).

METHODS

In order to investigate whether or not Toyah Phase people were more involved in bone grease production than Austin Phase people, a literature review was conducted to identify instances of grease extraction in Central Texas. Previously, in Chapter 9, archeological indicators for bone grease extraction behavior were defined. These include 1) a faunal assemblage that meet the criteria for bone grease processing, 2) hearths or other cooking facilities, 3) a diverse lithic tool assemblage, 4) fire-cracked or thermally-altered rock, 5) hammer stones, 6) groundstone, 7) ochre or other pigments, and 8) lipid residues with signatures consistent with marrow or bone fat.

Two of these indicators warrant additional discussion. Based upon ethnographic and historic research conducted by Katherine Seikel and Rachel Feit (see Chapter 9), ochre and/or other mineral pigments (e.g. hematite) were added to the list of proxy indicators for bone grease extraction behavior. Ochre and pigment stones are consistently overlooked in archeological discussions of bone grease processing, which focus almost exclusively on the activity as part of a food subsistence practice. The use of bone grease mixed with ochre and other pigments for grease paint is well documented ethnographically and historically; however, the practice is rarely addressed even in ochre-rich assemblages that also exhibit other markers of bone grease processing. Another indicator for bone grease extraction includes a diverse lithic tool assemblage. If a lithic tool assemblage indicated activities that would utilize bone grease as a component, such as hide processing and arrow shaft straightening, then such activities may also serve as a proxy indicator for bone grease production.

Items from the list above form a suite of evidence, which, when examined as a whole, provide potential indicators of bone grease extraction within archeological contexts. If four or more indicators appear within a site and post-depositional processes cannot account for the majority of faunal breakage patterns, bone grease is considered a likely activity which took place at the site. This analysis applied these criteria to the list of available archeological sites from Central Texas to determine the potential frequency of grease extraction in the region and to possibly identify changes in grease utilization over time (Appendix K).

A literature review including 38 archeological sites within Central Texas with a total of 52 temporal components was conducted. Site reports and publications were reviewed to determine the likelihood that bone grease processing occurred at each site. The focus of this review was primarily the Late Prehistoric period, though earlier site components were included for a small sample of sites (n=8) for comparative purposes. The temporal components of each site were separated from each other, whenever possible, in order to track potential change in grease utilization over time. A determination of the probability of bone grease extraction was then made for each component. Determinations of "no" were made for site components without clear evidence of bone grease extraction. A determination of "yes" was used for sites with clear evidence or high potential for grease extraction. A determination of "maybe" was assigned to components where there was potential for grease extraction but there was little or no discussion of taphonomic impacts on the faunal assemblage and/or more detail on the lithic and groundstone assemblages would be required to make a determination (see Appendix K). "Indeterminate" was assigned to any site component for which a determination was not possible due to faunal collection strategies or variations in reporting. All site components designated "indeterminate" were excluded from the analysis.

RESULTS

The literature review did provide some challenges due to variation in site reporting and the inclusion of burial sites in the review. Reporting on nine (17 percent) of the 52 site components reviewed did not contain the level of detail in the faunal data which would allow for a determination regarding bone grease extraction at the site. This was primarily an issue with sites that were reported prior to 1980, which privileged analysis of stone tools and debitage over faunal and other remains. Many of these studies only collected or analyzed identifiable taxa or provided no detailed description of the condition of the faunal remains. One of these sites included burials, and the associated report focused primarily on the burial components. The data reported from the other sites typically reported the taxa identified and weights of the collected faunal bone, but did not discuss the quantity of specimens collected or the condition of the assemblage in the type of detail required by this study to make a determination. These nine site components were designated as "indeterminate" with respect to bone grease extraction and were excluded from the following analysis. It is important to note that excluding these components also excluded eight (21 percent) of the 38 sites from the analysis. Appendix K contains a complete table showing attributes identified at each site component consider in this analysis, and Tables 11.1 and 11.2 and Figures 11.1 and 11.2 are provided below as summaries of the findings.

Table 11.1. Archeological Sites Associated with the TxDOT Hypothesis 2

#	Trinomial	Component/ Phase	Was Bone Grease Extraction Occurring?	#	Trinomial	Component/ Phase	Was Bone Grease Extraction Occurring?
1	41WM71	Toyah	No	27	41WM230	Austin	No
2	41HY202	Early Archaic	No	28	41WM230	Toyah	Yes
3	41HY202	Late Archaic	No	29	41HY209	Late Archaic	No
4	41HY202	Austin	No	30	41HY209	Austin	Yes
5	41HY202	Toyah	Maybe	31	41HY209	Toyah	Indeterminate
6	41ML35	Toyah	No	32	41CM1	Austin/Toyah	No
7	41GD4	Toyah	Yes	33	41TV88	Austin	Maybe
8	41KM16	Toyah	Maybe	34	41LK201	Toyah	No
9	41TG91	Archaic	Yes	35	41BN33	Austin	No
10	41TG91	Toyah	Yes	36	41BN33	Toyah	No
11	41BL104	Austin	Indeterminate	37	41WM437	Toyah	Yes
12	41SS20	Toyah	Maybe	38	41TG346	Toyah	Maybe
13	41KM69	Late Archaic	Maybe	39	41WM1010	Austin	Yes
14	41KM69	Austin	Maybe	40	41WM1126	Late Archaic	Yes
15	41KM69	Toyah	No	41	41WM1126	Austin	Indeterminate
16	41FY42	Austin	Indeterminate	42	41TV42	Austin/Toyah	Yes
17	41LL419	Austin	Yes	43	41TV441	Austin/Toyah	Maybe
18	41JW8	Toyah	Maybe	44	41ED28	Toyah	Indeterminate
19	41WM130	Austin/Toyah	Maybe	45	41BC114	Austin/Toyah	Maybe
20	41MM341	Late Archaic	Yes	46	41WM235	Paleoindian	Maybe
21	41MM341	Austin/Toyah	Yes	47	41WM235	Archaic	Maybe
22	41HM51	Toyah	Yes	48	41WM235	Austin/Toyah	Yes
23	41TV51	Austin	Indeterminate	49	41UV88	Early Archaic	No
24	41HI1	Austin/Toyah	Indeterminate	50	41ZV202	Austin	No
25	41BT105	Austin	Yes	51	41SS178	Austin/Toyah	No
26	41KM226	Toyah	Indeterminate	52	41SP220	Toyah	No

Table 11.2. TxDOT Hypothesis 2 Bone Grease Extraction Evidence by Site Component – Excluding Indeterminate

#	Component/ Phase	Bone Grease Extraction was Occurring and Percentage	Bone Grease Extraction was not Occurring and Percentage	Bone Grease Extraction maybe was Occurring and Percentage	Indeterminate (omitted)
1	PaleoIndian N = 1	0	0	1 = 100%	0
2	Early Archaic N = 2	1/2 = 50%	1/2 = 50%	0	0
3	Archaic N = 2	0	0	2 = 100%	0
4	Late Archaic N = 5	2/5 = 40%	1/5 = 20%	2/5 = 40%	0
5	Austin N = 11	3/11 = 27%	6/11 = 55%	2/11 = 18%	3
6	Toyah N = 17	7/17 = 41.2%	6/17 = 35.3%	4/17 = 23.5%	2
7	Austin/Toyah N = 5	2/5 = 40%	1/5 = 20%	2/5 = 40%	4

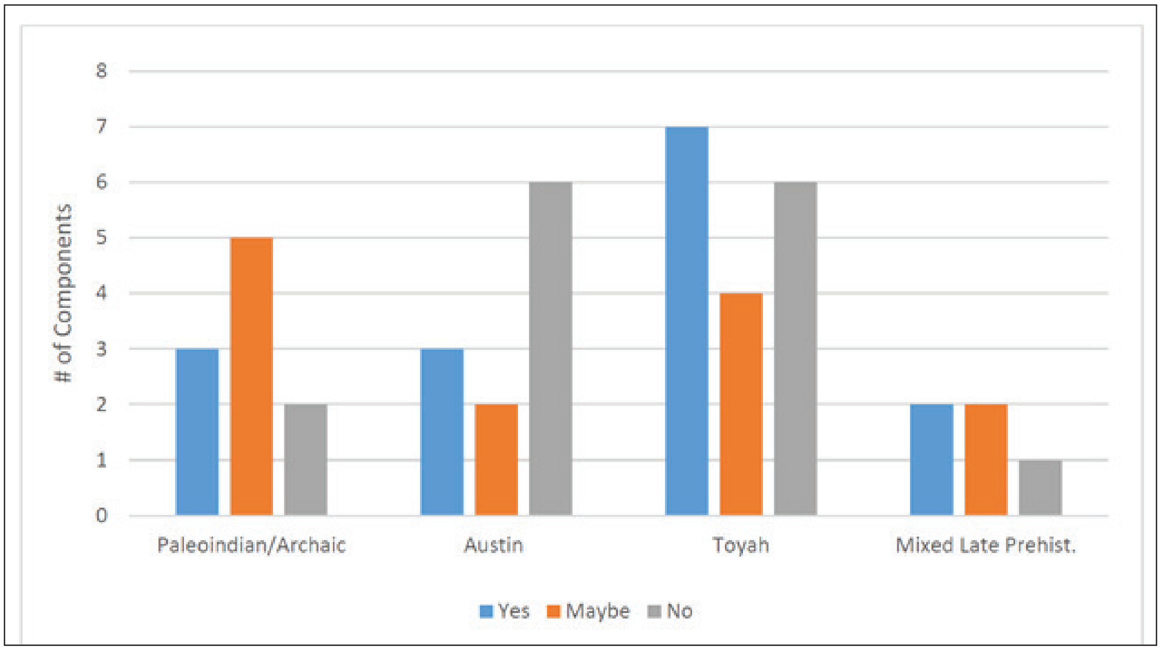

Figure 11.1. Frequency of Bone Grease Extraction by Site Component.

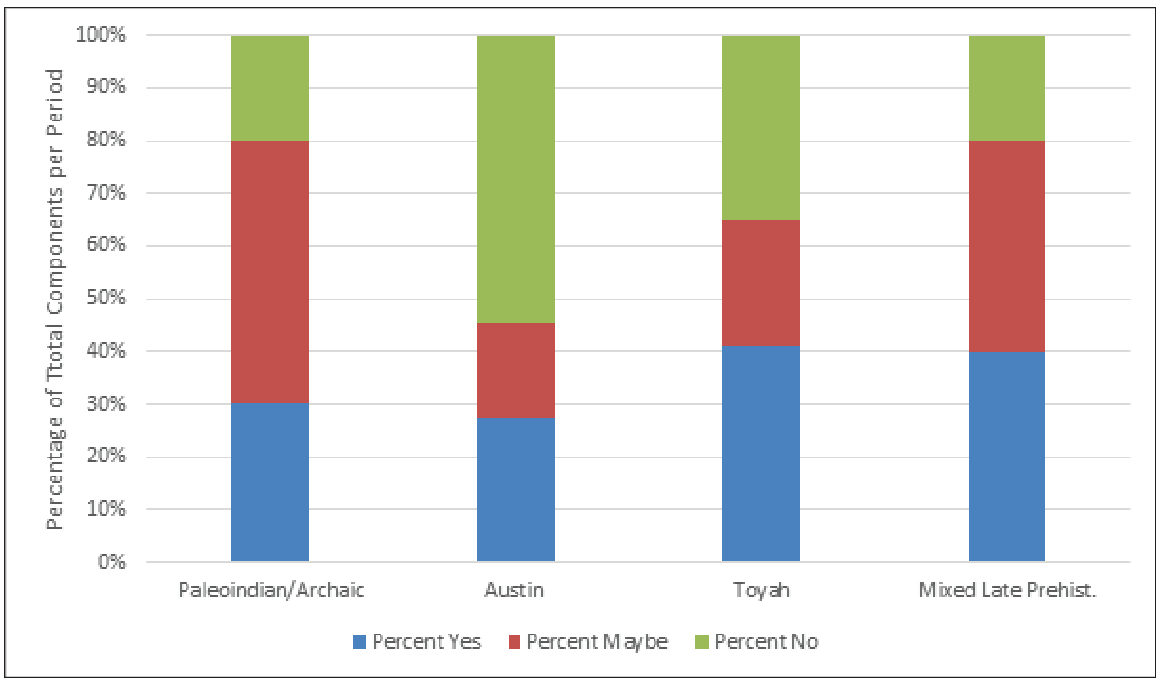

Figure 11.2. Frequency of Bone Grease Extraction Adjusted
as a Percentage of Total Components Per Period.

According to the parameters of this hypothesis, if a majority of Toyah Phase site components in the sample have indicators of bone grease extraction, then the portion of the hypothesis stating that bone grease extraction behavior was common during the Toyah Phase will be supported. The majority—in this context—is defined as "the greatest of the whole," even if by a small margin. This component of Hypothesis 2 is supported in that seven of the 17 (41.2 percent) Toyah components analyzed returned a positive result and six of the 17 (35.3 percent) returned a negative result for evidence of bone grease extraction behavior for the Toyah components (see Figure 11.2). This majority is marginal (only 5.9 percentage points), and not a strong indicator that bone grease extraction was a very common practice for Toyah peoples at all sites. However, if the potential evidence for bone grease extraction (those components in the "maybe" category) can be added to the positive column, the percentage of such components rises to almost 65 percent.

In addition, according to the parameters of this hypothesis, if the majority of sites from the Austin Phase lack the elements listed under the data requirements, then the portion of the hypothesis stating that bone grease extraction behavior was rare during the Austin Phase is supported. This portion of the hypothesis was supported in that six of the 11 (55 percent) of the Austin Phase components returned a negative result for evidence of bone grease extraction behavior. Alternatively, a total of three of the 11 components (27.2 percent) of the Austin Phase components returned a positive result for bone grease extraction behavior (see Figure 11.2).

Therefore, according to the parameters of TxDOT's Hypothesis 2 stating that data related to bone grease extraction behavior is common in Toyah Phase archeological sites, but rare in Austin Phase sites is generally supported by the available data when examined by percentage. Bone grease processing in Toyah Phase sites is relatively common (41.2 percent of the sample) and less was common in the Austin Phase (27.2 percent of the sample). However, there is not a clearcut dichotomy of the data from the Austin and Toyah phases (i.e., the percentage difference is 13.9 percent). A chi square analysis comparing the Toyah and Austin Phase results (excluding sites with potential; the 'maybes') demonstrates that there is a lack of statistical significance ($p=0.61$) between Austin and Toyah phases. The small sample size is sufficiently low that a definitive statement in support of Hypothesis 2 is not possible at this time. The small sample size may not reflect the reality of Late Prehistoric behavioral trends over time. However, this preliminary result supports some of the observations of other researchers who have noticed differences in bone grease extraction behavior intensity across the Austin and Toyah Phases (Thompson et al. 2012:129). Further investigation of this hypothesis including a larger number of sites and site components is important avenue for future researchers to either confirm or refute the results of this study.

There are several pieces of ancillary information revealed during this portion of the investigation. The analysis has indicated that bone grease extraction behavior has likely been going on for thousands of years, possibly varying in intensity over time. Additionally, Chapter 9 revealed that bone grease was used for a plethora of uses other than for foodstuffs including ointments, grease for shaft straighteners, bug repellent, hair dressing, and paint. Paint was a particularly important commodity for prehistoric peoples. The presence of ochre within archeological assemblages is common, based on the results of the sites review, and understanding that mixing its powdered form with bone grease creates paint generates an appreciation for its presence in archeological contexts.

Even though the dataset is small and the results can only be considered as preliminary, this analysis revealed that the intensity of bone grease extraction behavior was different during the Toyah Phase compared to the Austin Phase. This observation may lend support to the idea that what has been defined as Toyah may best be explained as outsiders migrating into Central Texas possibly displacing Austin Phase peoples or mixing with them. This is of course a preliminary interpretation of the data. Future additions to this dataset will need to be evaluated to either support or refute this interpretation.

However, this interpretation is consistent with some of the hallmarks of discussions of the impact of climatic changes on Late Prehistoric peoples (see Chapter 14). During the Medieval Warm Period (Austin Phase), warmer summers and milder winters allowed for an increased population pursuing agriculture on the peripheries of Texas (Foster 2012). During this time, the same mild winters and longer summers pushed the bison herds up to the northern plains. Central Texas was hot and dry supporting sparser populations. Hypothetically, since winters were short lived, pemmican was not an important staple over winter, and since summers were hot, pemmican may have not been a viable storable foodstuff due to spoilage from the heat. However, bone grease may have been produced for other uses (paint, ointments, grease for shaft straighteners, hid processing, etc.).

During the subsequent Little Ice Age (Toyah Phase), summers were cooler, wetter and shorter, while winters were longer and harsher. Shorter and much less predictable growing seasons plagued the agriculturalists living on the peripheries of Texas (Foster 2012). Longer, harsher winters pushed the bison herds down onto the southern plains (Creel 1991; Ricklis and Collins 1994). The agriculturalists may have adopted mixed subsistence strategy including more hunting and gathering (Perttula et al. 2014), which may have included migrations into Central Texas to hunt bison in order to survive. They brought their pottery with them, and adopted the Perdiz point which may have been easier to haft to cane arrow shafts (Johnson 1994). Cane and reeds (Phragemites) would have become more prevalent with the expansion of wetland areas and as a resource would have made the production of arrows easier (Johnson 1994:273). The new plains hunters would subsist on a wide array of plants and animals while pursuing deer, antelope, and bison. They possibly targeted the big game in part to process the meat into pemmican to survive the colder, harsher, unpredictable winters. Since bone grease is an integral part of pemmican, production may have intensified to meet increased dietary and socio-cultural needs. This may also explain the relatively denser populations in Central Texas during the Terminal Prehistoric Phase.

CHAPTER 12: HYPOTHESIS 3: THE PRIMARY REASON FOR THE EXTRACTION OF BONE GREASE AT 41HM51 WAS TO USE IT AS A COMPONENT IN THE PRODUCTION OF PEMMICAN

This chapter assesses the uses of bone grease at Site 41HM51 (the Jayroe Site) in Hamilton County, Texas. At the Jayroe site, a large, highly fragmented faunal assemblage, features and artifacts indicate that site occupants were rendering grease from the bones of animals they hunted and brought back to their camp. The TxDOT research design hypothesized that the primary purpose for bone grease extraction at the Jayroe Site was as a component in pemmican (see Chapters 3 and 9). The main ingredients in pemmican are pulverized dried meat mixed with rendered fat from animal bones. Pemmican is documented as a particularly important foodstuff to nomadic and seminomadic groups due to its portable nature and long shelflife (see Chapter 9). To examine the hypothesis, TxDOT proposed a series of testable parameters or criteria that would support or refute the premise that the primary reason for bone grease extraction at the Jayroe site was to make pemmican. The proposed methods to assess the parameters involved a review of ethnographic and ethnohistoric sources and archeological literature to provide a broad context for the production and use of bone grease in North America, as well as a re-evaluation of the Jayroe Site's faunal assemblage, lithic assemblage and other supporting data. The hypothesis would be supported if the majority of ethnohistoric and ethnographic sources "reveal that the motivation behind bone grease extraction was the production of pemmican," and if various lines of archeological data, particularly meat residues from groundstone artifacts, from the Jayroe site also support the interpretation that pemmican was being produced (see Chapter 3).

This chapter presents the methods and data used to test the hypothesis and then discusses the results of the literature review coupled with the various lines of data from the Jayroe Site to conclude whether the hypothesis is supported based on the criteria in the research design.

METHODS

A thorough review of ethnohistoric and ethnographic literature on the methods of extraction and uses of bone grease was conducted, and some of which was presented in Chapter 9. Archival research utilizing ethnohistoric, historic, and ethnographic accounts was conducted to provide a broad context for the extraction and use of bone grease by native groups. Materials associated with more than 20 cultural groups in North America were reviewed, though most of the groups included were Plains Tribes and their immediate neighbors. It was determined that the exploitation of bone grease for subsistence or other purposes was nearly ubiquitous across the examined cultures. The review also determined that the uses of bone grease include it being an additive to pemmican, a base for paints, hide curing, and other topical applications.

The results of the research clearly demonstrate that bone grease extraction and pemmican production were undertaken by many indigenous cultural groups in North America. Therefore, physical evidence of its processing or use should exist in the archeological record within numerous geographic regions. AmaTerra developed a list of criteria which may be associated with bone grease extraction, which have the potential to be preserved in the archeological record (see Chapter 9). Since bone grease is one of two base ingredients in pemmican, many of the criteria identified for grease extraction activities would also apply to pemmican production. One goal of this chapter is to identify additional cultural remains which may be indicative of pemmican production in the archeological record. Since Chapter 10 established that bone grease was an activity that took place at the Jayroe Site, this chapter addresses whether the primary use of bone grease at the site was as an ingredient in pemmican.

REFERENCE MATERIALS AND THE LITERATURE REVIEW

The primary archival source consulted in this study was the Human Relations Area Files (HRAF) web-based manuscripts collection. Additional sources utilized include the Bexar Archives, online reference material from the Bureau of American Ethnology (BAE), and other references identified using Google Scholar searches. References were reviewed for mentions of bone grease production, uses of grease or fats, pemmican production, and the trade of grease, fats, pemmican and/or related products by native peoples. Over 65 sources associated with 27 cultural groups were included in this review (Appendix L) in order to obtain a general idea how groups located in a variety of geographical areas produced and utilized bone grease, as well as provide perspective on spheres of interaction and trade between various groups.

Challenges for this study include the lack of ethnohistoric accounts of Texas groups in the HRAF database and other sources. Although the HRAF provided exceptional information regarding the production and use of bone grease among many North American tribes, specific information about the tribes of Texas was largely absent except for the Comanche and Apache, groups which likely spread into Texas in the Late Prehistoric and/or Proto-historic Periods. In an attempt to bridge this gap, researchers also consulted the BAE bulletins and reports archived online by the Smithsonian, explorer accounts such as Cabeza de Vaca's, as well as the Bexar Archives Online. While these sources are searchable by keyword, they are not as well indexed as the HRAF, and required greater time and effort to locate useful information. As a result, only seven (4 Apache tribes, 1 Comanche, 1 Bidais and 1 Caddo) of the 27 groups included in the review (26 percent) have ties to Texas.

Sources which may contain additional information regarding bone grease and its uses in Texas and the Southern Plains include additional references within Bexar Archives, early Texas settler accounts and letters, accounts of captives, and other ethnohistoric accounts. Similar sources were included in the literature review, however, limitations of time and variations in indexing methods precluded the inclusion of additional reference material in this review. Expanding the selection of sources consulted may provide additional insight for future archeological studies.

The literature review determined that the most commonly discussed uses of bone grease were as ingredients in foodstuffs (Buskirk 1986; Emmons and De Laguna 1991; Gelo 2006; Hungry Wolf 1980; Kennedy and Stevens 1972; Murie and Parks 1989; Swanton 1942). Pemmican was the most commonly discussed foodstuff, possibly due to its use as a common provision through winters, it was portable, and it was also used in feasts and ceremonies (Cooper and Flannery 1957; Gelo 2006; Long et al. 1961; Schultz 1980; Wildschut and Ewers 1960). The base ingredients of bone grease and pulverized dried meat remained constant, however, nuts, herbs, and berries were added based on the intended use of the pemmican and the region it was produced.

PEMMICAN IN PREHISTORY

Archeologists believe that pemmican production began on the northern plains between five and seven thousand years ago (Brink 1997:260; Colpitts 2015:10; Reeves 1990). However, pemmican production and use did not develop fully among Northern Plains tribes until the late Middle Prehistoric period around 3,000 years ago (Reeves 1990). Based on the greater number of pemmican references associated with Northern Plains tribes versus Southern Plains tribes, it is probable that the production and use of pemmican diffused from the northern plains, where it was considered a staple by the Euro-American contact period, to the southern plains. As such, pemmican production in Texas may be evident in the Late Archaic, if not earlier, due to evidence for bone grease extraction in Middle Archaic deposits in Central Texas (see Chapter 11).

There is disagreement over the causes leading to the adaptation and use of pemmican. Several researchers contend that bone grease extraction for pemmican and other foodstuffs is a sign of resource stress and food shortage (Binford 1978; Outram 2001, 2002). More recently, others have argued that bone grease use was an integral part of cultural processes (Prince 2007), which appears to be corroborated by the ethnohistorical literature.

Other research suggests that pemmican provisioning increased late in the prehistoric period due to an increase in conflict associated with the migration of various native groups during this time (Ray 1984:266). Group relocations may be linked to population pressure in the home territory or possibly environmental changes associated with the transition from the Medieval Warm Period to the Little Ice Age.

HISTORIC PEMMICAN TRADE

Based on the archival materials consulted, archeologists and historians have come to a consensus that large-scale pemmican production for trade was primarily a feature of the Euro-American contact and historic periods. Ray (1984:266) suggested that trade in grease and pemmican prior to the Euro-American contact period among nomadic Plains groups occurred primarily with sedentary horticultural groups and cannot be presumed to have been as extensive as later trade with Euro-American trappers and fur traders. Though various indigenous groups often shared pemmican provisions with visitors, it was not generally traded between native groups. It was primarily a commodity that, when shared, formed reciprocal relationships and social ties between individuals, families, and larger social groups (Nugent 1993). The construction of these relationships enabled groups to create reliable networks to draw on in time of food scarcity or social stress. Speth and Speilmann (1983:20) also suggested that trade between hunter-gatherer and horticultural groups prior to the contact period may have been more common in times of resources stress.

Although it may not have been as pervasive among native groups during the pre-contact period, by the early contact period, pemmican production and trade was probably well integrated into many tribal economies, particularly in the north. After the seventeenth century, the Northern Plains tribes, particularly the Assiniboine, the Western Woods Cree, and Blackfoot developed a large-scale pemmican production and trade complex with European trappers, soldiers and explorers (Colpitts 2015; Kennedy and Stevens 1972). The large-scale pemmican production and trade complex “created arguably unique relationships based on obligations and rules of reciprocity” among Native American groups and newcomers (Colpitts 2015; Kennedy and Stevens 1972). In exchange for the pemmican provisions, Europeans gave Native Americans beads, guns, horses, metal tools, and metal kettles. Access to copper and brass kettles and pans increased the efficiency of bone grease extraction during the historic period (Ray 1984), though the market production of pemmican on the northern plains was significantly different from the traditional product in process and quality (Colpitts 2015). This increase in efficiency enabled the commercialization of pemmican production on the Northern Plains to provision the fur trade. European reliance on Native American pemmican increased throughout the eighteenth and nineteenth centuries enabling the fur trapping and trading industries to flourish on the Northern Plains (Colpitts 2015).

Ethnohistoric accounts demonstrate that Southern Plains groups, and the Comanche in Texas, also produced pemmican during the historic period. However, pemmican is only referenced in materials reviewed from two of the seven groups with ties to Texas, the Comanche and Eastern Apache (Gelo 2006; Opler 1941; Wallace and Hoebel 1952). Pemmican is only mentioned in 38 percent of the referenced material from Texas, which suggests a difference between the importance and/or use of pemmican between the Northern and Southern Plains groups. The regional differences in the frequency at which pemmican is referenced in ethnohistoric and ethnographic literature could be due, in part, to climatic differences and the widespread use of pemmican to provision trappers and fur traders on the Northern Plains. This was not the case for the Southern Plains groups; it appears that pemmican was not typically traded to other tribes or groups in Texas. Among the Comanche, each band produced its own pemmican mainly as food supply for winter or for long hunts (Wallace and Hoebel 1952). However, during the early historic period it has been documented that indigenous groups in Texas, including the Apache, Comanche, and Bidais, traded bison meat, jerky, tallow, suet, hides, and possibly pemmican for tobacco, guns, and other goods from the Europeans and neighboring sedentary indigenous groups (e.g., Puebloan groups to the west and the Caddo) (Bexar Archives; Mitchell 2016; Newcomb 1961). Pemmican is rarely mentioned as one of the trade items received by Europeans. In the ethno-historic sources reviewed for this study, there is only one reference to pemmican trade among indigenous groups of the Southern Plains (Arnon and Hill 1979).

NON-DIETARY USES OF BONE GREASE

Although pemmican's importance in pre-contact North America cannot be disputed, its manufacture was not the only use of bone grease. Additional uses for bone grease common to the cultural groups reviewed include water proofing for hides, an oily base for paints, sunscreen and/or protection against chapped skin when mixed with specific clays or minerals, insect repellant, a means to remove face or body paint, and sealant for food storage containers (e.g., Denig and Hewitt 1930; Morgan 1959; Smith 1974; Swanton 1942, 1946; Wallace and Hoebel 1952). In addition to these general uses, the Comanche used bone grease in their process of straightening arrow shafts (Wallace and Hoebel 1952). Bone grease mixed with ochre is particularly notable because of its importance in ritual, spiritual, and physical domains, but also because of its preservation potential in the archeological record. The practice of making grease paints and some other topical applications of grease would theoretically be visible in the archeological record through the appearance of ochre and pigment minerals alongside other indicators of bone grease extraction (see Chapter 9).

In summary, although not all the sources reviewed discuss bone grease extraction explicitly, nearly all the reviewed materials inferred the extraction of bone grease by discussing its many uses. Fifty-eight percent of the references discuss pemmican production or ingredients used in pemmican production, 13 percent note the use of bone grease in other foodstuffs, 23 percent note the use of grease in mixing paints, 13 percent include accounts of greasing the skin or hair, and 15 percent note the use of bone grease in other activities (e.g. preparing hides, polishing pipes, etc.; see Appendix L). The results of the literature review show supporting data for TxDOT's hypothesis in that the majority of references reviewed mentioned pemmican. However, bone grease was used for many purposes beyond subsistence and the prevalence of pemmican in referenced accounts may be impacted by the relative interests and/or background of the recorder (e.g., anthropologists versus traders) and the amount of time they spent with indigenous groups.

ARCHEOLOGICAL CONSIDERATIONS OF BONE GREASE EXTRACTION AND PEMMICAN PRODUCTION

Archeological considerations of pemmican production overlap with the criteria outlined for grease extraction in Chapter 9 (listed below). The presence of ochre or pigment stone within a site (Criteria 7) is not relevant to the production of pemmican. However, residue analysis of lipids should be expanded to include proteins to determine possible signatures of meat grinding on groundstone tools as support for pemmican production.

1) Presence of hearths and other cooking features.

2) Presence of fire-cracked or thermally altered rock.

3) A faunal assemblage containing medium to large animal remains and with high frequencies of small indeterminate mammal bone fragments.

4) Presence of a diverse lithic tool assemblage.

5) Presence of hammerstones.

6) Presence of groundstone.
7) Presence of ochre and/or other pigment stone.
8) Lipid residue signatures from tools and ceramics that are consistent with marrow and other bone fats.

Additionally, residue of plant remains that may have been used as supplemental ingredients in pemmican could be used as supporting evidence of pemmican production where other criteria are met. Remnants of meat drying racks or stored/cached pemmican could be included in the list of criteria used to determine pemmican production, however, such materials may not preserve in the archeological record.

SITE 41HM51: THE JAYROE SITE AND EVIDENCE FOR PEMMICAN PRODUCTION

Chapter 10 already makes a case for bone grease extraction at site 41HM51, so the data analysis presented there will not be reiterated here. It was determined that the site met the seven criteria for bone grease processing which are relevant to pemmican production. This section reexamines the organic residue analysis (Appendix H) in relation to evidence for meat processing potentially associated with pemmican production.

This section focuses on the residue analysis results from the lithic tools and groundstone artifacts at the Jayroe Site, since smoking meat did not require the use of ceramic vessels. Groundstone artifacts exhibited plant and animal residues, suggesting the use of groundstone artifacts for processing both floral and faunal foodstuffs. Sample 423-1, an anvil, exhibited lipid residues associated with the pounding or grinding of meat (Appendix H:8). Evidence of fats/lipids, proteins and carbohydrates were recovered from the thick groundstone slab, sample 470-2 (Appendix H:8). The presence of pectins among the various polysaccharides on this slab fragment suggest fruit or vegetable processing, many of which could have been used in pemmican amongst other foodstuffs. The sample from the mano had meat, cellulose, and pectin residues, which are consistent with the grinding of meat and possibly plant materials (Appendix H:8). The chipped stone tools exhibited use primarily for processing animals, namely rabbits and possibly bison and eels (Appendix H:8). The results of the organic residue analyses are indicative of a wide range of subsistence practices, including butchering animals and the processing of meat and plants. Evidence for the grinding of meat provides the best support that pemmican production occurred at the site. Ground meat may have been used in other foodstuffs, however, the only obvious documented use of ground meat or jerky in the records reviewed was pemmican. The only other food processing activities that might have a similar archeological signature to meat grinding would be the use of groundstone slabs as anvils during marrow extraction or the possible use of slabs as butcher blocks though experimental studies would be needed to determine patterning in protein and lipid residues between different processing activities. The evidence of meat residues on the groundstone artifacts recovered from 41HM51 supports the hypothesis by meeting the second parameter outlined in the research design.

RESULTS

This study finds the hypothesis arguing that the primary purpose for the extraction of bone grease at the Jayroe Site was as a component in pemmican is supported, based on the parameters outlined in TxDOT's research design. Fifty-eight percent, the majority of the ethnohistoric references reviewed, mentioned pemmican or the ingredients in pemmican. In addition, the general suite of faunal remains, features and artifacts support the idea that bone grease processing occurred at the site, and residues of meat and possible additives to pemmican were recovered from groundstone artifacts from the site.

However, there are a few findings of the research that should be taken into consideration, which present complications to the hypothesis and the parameters outlined to test it. The primary finding has to do with the wide range of uses of bone grease. The ethnohistoric and ethnographic review found that pemmican production was only one of several uses for bone grease in prehistoric North America and none of the sources referenced in this study suggested that grease use was limited to subsistence. Therefore, evidence of bone grease extraction should be examined beyond its dietary uses. The second most commonly referenced use of bone grease in the overall literature review was the mixing of mineral pigments with grease for use in paints (23 percent). Archeological literature reviewed for sites in Texas suggests a strong correlation between sites with evidence of bone grease extraction and the presence of ochre. Of the 18 sites that seemed to have clear or likely indications that bone grease rendering was among the site activities, 11 of them also contained ochre in the assemblage. Several sites, such as the Toyah Bluff Site (41TV441) and the Rush Site (41TG436), contained ochre in association with groundstone, cooking features, and fractured faunal elements (Karbula et al. 2001; Quigg and Peck 1995). At the Jayroe Site, 38 fragments of ochre were recovered and one of these was affixed to a grinding slab. This evidence supports an interpretation of non-dietary uses of bone grease at the site, although it does not necessarily refute Hypothesis 3.

Another complication presented in the analysis is that ethnohistoric documents only covered a relatively small number of tribes in Texas (26 percent; 7 of 27 total groups). Of the eight references associated with the seven Texas groups only three (38 percent) refer to pemmican. In fact, the number of times pemmican production is mentioned among Texas groups is significantly lower than the overall review percentage of 58 percent, which may indicate that pemmican was not as common in Texas as it was in other parts of the continent. When pemmican production was mentioned, it was discussed in reference to provisioning individual bands or small groups rather than part of a large-scale production and trade complex common among Northern Plains tribes. Additionally, two (25 percent) of the eight references mention the use of grease in mixing paints, which is consistent with the overall 23 percent documented within the broader literature review. Although, these results may indicate lesser emphasis on pemmican in Texas, the sample size is small and there was generally little detail regarding grease use among groups associated with Texas.

The lack of detail regarding Texas tribes was also a limitation stemming from the difficulty of identifying and locating records associated with them. The electronic HRAF records provide little information on groups native to Texas, though there is extensive information relating to Northern Plains groups. Part of this informational gap may be due to the digitization process, but it is possible that some early ethnohistoric accounts may not have identified the cultural group with which the author or informant interacted. Much of the information regarding Texas tribes involve plains groups which moved into Texas and the Southern Plains from the north (e.g., the Comanche and Apache), which was particularly apparent in reviewing material available in the Bexar Archives and other publications. The lack of information regarding Texas tribes, particularly those originating from Central Texas, may be an artifact of socio-cultural changes associated with the settlement and/or incursion of new groups in the region during the protohistoric and early European or Euro-American contact periods. Tribes local to Central Texas would have been significantly impacted by diseases introduced by European explorers and Euro-American settlers and may have been further decimated by conflicts with later groups (e.g., the Comanche and Apache) moving into Central Texas. If that is the case, accounts may be biased towards the documentation of groups which occupied the area more recently, or more recently formed groups comprised of members descending from different cultural traditions. Further ethnohistoric research utilizing other sources may be required to determine the relationship between local Texas groups, bone grease extraction, and pemmican production.

In summary, though the hypothesis was supported based on the parameters outlined in the TxDOT research design, further research into grease and pemmican use by a wider range of tribes originating from within Texas may be beneficial to build a better understanding of how the production and utilization of pemmican may have varied within the southern plains in comparison to the northern plains. Additionally, Chapters 9 through 12 demonstrate various difficulties in identifying bone grease extraction in the archeological record, which are compounded in attempting to recover evidence of all its potential uses within a given site assemblage. Therefore, we conclude that pemmican was being produced at Site 41HM51, other uses of bone grease within the site should be considered.

CHAPTER 13: HYPOTHESIS 4: THE SITE'S LITHIC ASSEMBLAGE SUGGESTS THAT THE SITE'S TOYAH PHASE OCCUPANTS ENGAGED IN VERY LIMITED MIGRATORY BEHAVIOR

Non-local and/or exotic materials were recovered from 41HM51 in the form of Caddoan ceramics and obsidian. However, the 41HM51 chipped stone assemblage is overwhelming comprised of chert, which can be derived from sources much closer to the site area. One possible source is the chert beds that underlie the Edwards Plateau located 60 miles west of the site. As part of the normal weathering or erosional process, chunks of chert break off from the beds and are transported downstream, tumbling in streams and rivers forming nodules. These nodules can travel dozens if not hundreds of miles becoming smaller as they tumble further from their source.

Site 41HM51 is located on the bank of the Leon River, a major river in Central Texas. There are also multiple smaller drainages located within walking distance to the site. Most, if not all, of these drainages flow southeast. Therefore, chert in the form of stream rolled nodules could have been available in close proximity to the site as well as west of the site. To the east, the availability of raw chert nodules diminishes.

Ultraviolet florescence (UVF) studies have been successful in identifying chert sources within known and defined potentially associated regions (Dockall 2014; Newlander and Speth 2009). If the site inhabitants engaged in a large range of movement, such as the area between the 41HM51 site location and obsidian sources in New Mexico, they would have had access to a wider variety of raw material sources with distinctive differences in their chemical composition. These sources would include the Edwards Plateau as well as a range of other chert sources. Each one of the chert sources would possess a distinct chemical composition (Dockall 2014; Newlander and Speth 2009). The residue of chipped stone tool manufacturing in the form of tools, tool fragments, cores, and debitage within the site's lithic assemblage would therefore reflect a wide variety of raw material types. However, if the lithic assemblage is confirmed to be mostly comprised of raw materials available locally, then it supports the hypothesis that the mobility of the site's inhabitants was limited. This chapter explores the issue of group mobility and trade with the hypothesis that the sites lithic assemblage suggests that the site's Toyah Phase occupants engaged in limited migratory behavior.

METHODS

One method for determining the geographic sources of chert raw material involves observing chert samples under ultraviolet (UV) light; a technique known as UVF. Chert materials from the same geographic source would share identical chemical compositions that are characteristic of that source, and cherts generated from different sources possess different chemical compositions. Based upon a sample's chemical composition, it will turn a particular color when observed under UV light. Chert samples from the same geographic source would display a common color when viewed under UV light (Newlander and Speth 2009). Conversely, cherts generated from separate sources would possess different chemical compositions and would display different colors when compared under UV light.

Over the last few decades, archeologists have been collecting samples from a large variety of chert sources in and around Texas. These collections are held in research facilities, university collections, and by consulting firms. The rationale for these collections is to create a reference collection of samples from known chert sources for comparison with chert artifacts from archeological sites. If a chert artifact from an archeological site generates the same color as chert samples from a known source when both are observed under UV light, then it is considered confirmation that that chert artifact generates from that source. Conversely, if a chert artifact displays a different color under UV light from a known source sample, then it is considered confirmation that that artifact did not generate from that particular source.

John Dockall PhD., of Prewitt conducted comparative UVF analyses of chert artifacts recovered from 41HM51 (see Chapter 5 and Dockall 2014). The analyses were conducted using techniques outlined in Newlander and Speth (2009:48). All of the chert artifacts (319 tools and 6,580 flakes) from 41HM51 were analyzed and compared to Prewitt's Archeological Laboratory's chert reference collection. The reference collection consisted of samples from 13 known sources including the Texas Panhandle, Alibates (Potter County, Texas), Edwards Chert, Winchell limestone materials (Pennsylvanian), Ranger limestone materials (Pennsylvanian), Tecovas (Potter County, Texas), Potter chert (Potter County, Texas), Ogallala quartzites (Garza County, Texas), Black to dark gray, microfossils (Bosque County, Texas), Justiceburg Reservoir chert samples, Caballos novaculite/Maravillas chert (Brewster County, Texas), and chert cobbles from Pecos County and Brewster County, Texas. In addition, as part of this study Dockall collected raw chert samples from several sources in the Leon River Basin in vicinity of the site for comparison.

If the UVF lithic analysis results in the determination that a statistically significant majority of chipped stone artifacts were generated from local chert sources, then the hypothesis is supported. However, if the analysis identifies chert sources that are not local, then the hypothesis is refuted. If the hypothesis is supported, then that corroborates the supposition that the Toyah Phase occupants were limited in their range of migratory movement and stayed within a relatively limited territory. Therefore, the most likely explanation for the presence of exotic artifacts within the site would be that the Toyah Phase occupants were engaging in long distance trading behavior to acquire the obsidian from New Mexico and Caddoan ceramics from East Texas that were recovered from the site.

RESULTS

Dockall's comparison of the chert samples obtained from 41HM51 with the chert samples obtained from the reference samples resulted in the determination that the site's chipped stone assemblage is dominated by Edwards Group cherts likely generated from the Leon River Valley (see Chapter 5 and Dockall 2014). Site 41HM51 is located on a bank of the Leon River and Dockall's UVF analysis determined that the site's chert did not generate from the Panhandle, from west or east Texas, and did not come from western Louisiana. This determination is based upon observations of shortwave UVF spectrums ranging from yellow to yellow-orange to orange. Edwards Group chert specimens have color ranges toward orange or orange-red when they are heavily burned, and yellow-orange to orange when unburned (see Chapter 5 and Dockall 2014).

Dockall's (2014) analysis did encounter a total of four chert samples that did not fluoresce as Edwards Group chert. Three of these included a chopper tool and two flakes. All three displayed a deep purple fluorescence with the chopper and one flake displaying white microfossils. The chopper likely generated from a river or creek drainage and not from a primary geological outcrop due its observed stream rolled, weathered, surface cortex. According to Dockall (see Chapter 5 and Dockall 2014), these three artifacts may represent Pennsylvanian cherts from the Ranger and Winchell formations, which crop out in the upper Leon River basin (and north and northeast of the basin) northwest of the site. Finally, one small retouched flake of fine-grained black chert did not exhibit any fluorescence under the UV light and may represent a piece of Owl Creek Black chert. According to Frederick et al. (1994:15), of all the bedrock sources of chert that crop out near Fort Hood only the Owl Creek Black chert did not fluoresce.

The results of Dockall's UVF study suggests that the range of chert raw material procurement for the site's chipped stone tools was geographically limited. Only four pieces of material could be qualitatively identified as possibly originating within the Bosque River drainage to the east and southeast. In Dockall's (2014:4) own words:

> While some materials from the south of the site, towards the Fort Hood area, may be within the assemblage, it currently appears that the bulk of raw material procurement was within the Leon River drainage basin from a variety of procurement settings, but focused on the better quality Edwards Group cherts.

Based upon the results of Dockall's study (see Chapter 5 and Dockall 2014), most of the raw chert material was derived locally. This result supports the hypothesis, so the site's lithic assemblage suggests that the site's Toyah Phase occupants engaged in limited migratory behavior. One of the simplest explanations of the occurrence of exotic materials within the site artifact assemblage is that the site occupants interacted and traded with other migratory groups and/or traders rather than visiting the source areas themselves. The exotic materials recovered at site 41HM51 consist of a small amount of obsidian sourced from the Jemez Mountains in New Mexico and Caddoan pottery sourced from East Texas. Since the hypothesis is supported, it follows that the site's terminal prehistoric occupants remained within a relatively limited geographical range probably within a region including this section of the Leon River basin. The results of this analysis support the supposition that limited migratory ranges within Central Texas may be associated with the increase in groups utilizing hunter-gatherer subsistence strategies and competing for resources during the Little Ice Age.

CHAPTER 14: HYPOTHESIS 5: THE ARTIFACTS FROM THE SITE'S TOYAH PHASE CAN BE USED TO TEST SHAFER'S PRAIRIE CADDO MODEL

Site 41HM51 is located on the Leon River in Central Texas and dates to the Late Prehistoric. This geographic region and period may come under the prevue of Shafer's Prairie Caddo Model (2006). For this reason, TxDOT recommended that Shafer's model merited consideration during the interpretation of site 41HM51. For lack of a better mechanism early in the research design process, TxDOT proposed a simple hypothesis to include Shafer's model in the forthcoming research (see Chapters 3 and 9). This hypothesis posited that the artifacts from the site's Toyah Phase can be used to test Shafer's Prairie Caddo Model.

The data required to test this hypothesis was generated from 41HM51's Terminal Prehistoric Phase faunal, lithic, and ceramic assemblages. These assemblages would be assessed to confirm the presence or absence of material cultural associated with Prairie Caddo peoples as defined by the Prairie Caddo Model (Shafer 2006). Artifacts identified as associated with Prairie Caddo groups include metapodial beamers, Alba/Bonham projectile points, Gahagan knives, and early Caddoan pottery. TxDOT contracted with the Prairie Caddo Model's author, Harry J. Shafer, to compare his model with the 41HM51 site components, data, and assemblages. Shafer's assessment of the Prairie Caddo Model in relation to the Terminal Prehistoric occupation of site 41 HM51 is provided below as the bulk of this chapter, though the conclusions are those of the other contributors.

HARRY J. SHAFER'S REVIEW OF THE PRAIRIE CADDO MODEL IN RELATION TO 41HM51 AND HYPOTHESIS 5

The Jayroe Site (41HM51) is not a meaningful test for the Prairie Caddo Model, as the temporal span of the model covered the occupation at the George C. Davis Site (ca. A.D. 1000–1300). The Toyah occupation at 41HM51 took place during the fifteenth century, after the period of time attributed to the Prairie Caddo Model. Furthermore, with the onset of the Little Ice Age (ca. A.D. 1300–1850) and the influx of bison into central Texas, the social and demographic patterns in Texas and elsewhere changed dramatically between A.D. 1000 and 1300 and the Toyah occupation of 41HM51 (Arnn 2012; Ricklis and Collins1993).

FRAMING THE PRAIRIE CADDO MODEL

My curiosity about the presence of like artifacts in Central Texas to the early Caddo George C. Davis site material assemblage led me to give a paper proposing a connection between the two areas at the Texas Archeological Society meeting in Waco, Texas in 2003. Dr. Nancy Kenmotsu, then head of the archeology division at TxDOT, encouraged me to develop the paper. She and Dr. Lain Ellis invited me to write a module to set up a research model for investigating the possible connections between the people of the prairie and the Davis Site Caddo. While there were certain artifacts held in common between the two components, namely, pottery, Bonham-Alba arrow points, and Gahagan bifaces, there were other artifacts that might also relate to such connections such as deer metapodial beamers, and bone needles based on the concept of technological style associated with the Caddo and Woodland derived cultures of the Eastern and Plains areas. The model's time bracket was ca. A.D. 1000–1300. This early Caddo phase occurred during a climate interval known as the Medieval Warm Period (Foster 2012). This time slot takes 41HM51 out of the equation for the simple reason that it dates after the time proposed in the Prairie Caddo Model and within the time period of the Toyah Phase, during a climate interval known as the Little Ice Age. This does not mean, however, that the Toyah component at 41HM51 could not be the product of a Caddo or Caddo affiliated group, as will be explained below.

CADDO PRESENCE IN CENTRAL TEXAS AND PRAIRIE CADDO MODEL

There are a number of ethnographic references to the presence of Caddo peoples in Central Texas at the time of European contact during the later stages of the Little Ice Age. The magnet that drew these groups into Central Texas was the presence of bison, as chroniclers repeatedly mentioned bison as being the main economic pursuit (Newcomb 1961:138; Wade 2003:32, 154–155). Groups or coalitions of tribes were coming from west Texas (Creel 1991; Ricklis and Collins 1994:18, 19; Wade 2003:61, 112), Mexico (Wade 2003:32) east Texas (Creel 1991; Swanton 1942:136, 137), and Central Texas (Castenada 1939; Wade 2003:113, 114). Many bands, tribes, and even coalitions of tribes came into Central Texas, and Caddo (Hasinai) were among them. The economic reason was more than just hunting bison, as explained below.

Perttula (2016, 2017, 2018) has published informative papers on Caddo pottery in Central Texas that shows a mere sample of what is present in the archeological record. Perttula's study showed that the date range for Caddo pottery in Central Texas extends from Early to Late Caddo and is not restricted to Early Caddo covered in the Prairie Caddo Model. Early Caddo pottery is far more common than the published archeological record indicates. There has been regrettably little professional archeological work in the area where the pottery is most common (Ellis et al. 2015). The shame is that most of the archeological sites along the eastern flanks of the Edwards Plateau and Blackland Prairie along the Leon River and its tributaries where the pottery was most frequent have been thoroughly looted. Frank H. Watt (1953) was the first to bring attention to the extent of Caddo pottery in Central Texas. Stephenson's (1970) and Jelks' (1962) work at Lake Whitney confirmed Watt's findings. Later Edward Jelks made an effort to test sites with Caddo pottery components along the Leon River and its tributaries in the Belton Lake Area (Shafer et al. 1964), and Dee Ann Story pursued the search by leading a University of Texas field school at the Chupick Site near the mouth of Aquilla Creek in McLennan County.

I had long had an interest in the presence of Caddo pottery in Central Texas. A survey of artifacts in sites across the prairies of Central Texas and along the Leon and Bosque Rivers that had early Caddo pottery revealed some similarities with the ceramic and lithic assemblages at the George C. Davis Site as spelled out in the Prairie Caddo Model (Shafer 2006). Two artifact groups stood out, early Caddo pottery and Gahagan knives. The Central Texas connection with regards to Gahagan knives was clear, in that detailed analysis of the lithics artifacts, including debitage, at the George C. Davis site showed that the knives were imported and not manufactured locally. There was no reduction waste attributable to Gahagan manufacture and the size of the knives required them to be made at or near the Edwards chert raw material source. Chert types present in the Gahagan sample from the George C. Davis Site could also be traced to western Bell County. The connection appears solid. As for the pottery, the types Pennington Punctated Incised, Weches Fingernail Impressed, Holly Fine Engraved, and Davis Incised recovered from sites in Central Texas have been sourced to East Texas, and were not locally produced (Creel et al. 2013; Perttula 2018). Furthermore, there is a brief interval, ca. A.D. 1100–1200, during which Bonham-Alba points occur in the archeological record. Four sites have provided stratigraphic components that confirm, in my opinion, this brief interval that comes at the end of the Austin Phase and just prior to the Toyah Phase, these sites include the Kyle Site (Jelks 1962) and Urbankte Site at the confluence of Horse Creek and Leon River in Coryell County. I tested the latter site as an avocational archeologist and used the data in the module on the Prairie Caddo. The Urbankte assemblage included Pennington punctated and Davis incised pottery, a Gahagan biface, and Bonham-Alba arrow points. A single Scallorn point also was recovered. The Baylor site (Mehalchick and Kibler 2008; Story and Shafer 1965) on the Bosque River and the Clark Site (Watt 1964) are the other two sites with the Bonham-Alba point interval.

The sharing of certain artifact types was not enough to convince me at the time that possible Caddo groups were in Central Texas. After all, the prevailing assumption is that the artifact exchange was the product of interregional trade. What distinguished the Caddo culture from the hunters and gatherers in Central Texas in the first place? The Caddo were part of the Southeastern Cultural Area and descended from earlier Woodland Cultures of the Eastern United States. Woodland cultures (and by extension prehistoric Caddo) had their own technological style of doing things as all cultures do. The notion of technological style is widely used in the American Southwest and elsewhere (Hegmon 1998, among others) to describe the process of handing down traditional and technological knowledge and behavior from one generation to the next. More will be said of this concept below.

Another example in the Caddo case is dress. The Caddo were known for their brain-tanned deer skin clothing that included shirts, leggings, moccasins, and skirts (Newcomb 1961:291, 292), all Southeastern Woodland style dress. Bison skin was used for many objects as well. Recall that the time period of the Toyah was during the Little Ice Age when winters were quite cold and dressing against the cold was warranted, creating additional demand for deer and bison hides. Tanning and softening the hides required draping them over a log or beam and scraping with a deer metapodial beamer in a draw-knife motion. Why not use a stone scraper? The bone beamer would not cut the hide but would remove the undesired tissue. Use of deer metapodial beamers was not exclusive to the Caddo but was widespread throughout the eastern United States and Plains. It does not appear to have been a tool used west of the one-hundredth Meridian. I suspect this absence was because communities living in the hill country and southern and western Texas had different clothing and technological methods for tanning, based on what is known from the perishable record. It seems that rabbit fur was the cloak of choice (Shafer 2011:125–127). Beamers might have been something that the inhabitants of 41HM51 might have used, but the artifacts recovered from 41HM51 do not include beamers.

The Prairie Caddo hypothesis has been rejected by archeologists at Prewitt (Fields 2017; Mehalchick and Kibler 2008:72–73) who contend that the people of the prairie were hunters and gatherers and not members of the more agricultural Caddo culture. Fields' argument is based on the data from a single example, the J. B. White site in Milam County, where the Prairie Caddo lithic assemblage was present but not the pottery. However, if one adds the McGuire's Garden Site (41FT425) in Freestone County that had a very strong Caddo artifact assemblage and maize (Gadus et al. 2002), and the Asa Warner, Baylor (Story and Shafer 1965), and Rowe Valley (Rush 2013; Rush et al. 2015) sites, one might come up with a different perspective. In other words, I understand where Fields and others have alternative views regarding the Prairie Caddo Model and am very pleased to see the broad discussions that the model generated. That was the purpose. I do not argue against the idea that the indigenous peoples west of the Brazos River were hunters and gatherers. Taylor and Creel's (2012) comparison of Central Texas hunter-gatherer dental traits with Caddo traits failed to identify close relationships. However, sites like Kell Branch in Bell County (Watt 1936), and the mass burial at Waco (Watt 1937) and many other Central Texas burial samples were not available for analysis. In other words, there are a lot of exhumed burials in Central Texas that will never be sampled. Kell Branch would have been interesting to include in the sample, as one of the burials contained an individual that was shot with a Bonham arrow point.

The real conundrum for archeologists is in determining social identity from material culture, something that Arnn (2012) and Hegmon (1998) have addressed. Furthermore, special function sites such as hunting sites may not have the complete material assemblage as a residential site does. Lewis Binford (1983:133–138) pointed out decades ago differences in site function. Not all the artifacts used to identity a particular component will be present in special function sites. Sites like J. B. White and other sites along the Leon River may indeed have been hunting camps by people related to the Caddo. That was precisely why I ventured outside the box and employed the concept of technological style because it is more useful in determining social identity than the customary typological approach.

ON TECHNOLOGICAL STYLE

The concept of technological style has been widely applied across the American Southwest and elsewhere to define social boundaries (Hegmon 1998), and the paper by Heather Lechtman (1977) really inspired my thinking on the subject. Technology and material culture have always been of particular interest of mine, especially lithics and ceramics. I have also been intrigued with how geographic patterns in material culture might relate to cultural and ethnic groups. Texas archeologists beholden to typology rely on that attribute as a determining factor of defining and plotting the geographic boundaries of archeological cultures. It is not far removed from the old trait-list concepts applied in the mid-twentieth century (Davis 1961).

The notion of technological style incorporates a number of material components that appealed to me in the search for a more meaningful understanding of the presence of shared items between Davis Site Caddo and eastern Edwards Plateau ca. A.D. 1000–1300. In other words, I was reaching for something beyond mere typology and the distribution of point and pottery types in the realm of cultural behavior to better understand why so much early Caddo pottery was showing up along the eastern boundary of the Edwards Plateau, as well as Gahagan knives and Edwards chert in the Davis Site assemblage. Technological style relates to a groups behavior and customary way of doing things, from building houses, dress, tools, and beliefs, and how the houses, dresses, tools, and other paraphernalia are made. The Comanche made skin tipis; the Caddo made round grass houses. The concept takes into consideration the patterns of technological behavior that are passed on historically, taught or copied, from one generation to the next and is often expressed ethnically in material culture. We all learned from our forbearers. It occurred to me that the Caddo and preceding Woodland cultures in east Texas were part of the much wider network of Woodland and Woodland descendant cultures in the eastern United States. I then started to look closely at the material culture of Woodland cultures and their descendants to see what items were present in East Texas and of those, which ones extended geographically into Central Texas. It was on this trajectory that I began to explore more deeply the possibility of early Caddo presence in Central Texas.

A case in point for a particular technological style is the manufacture of Woodland Period Gary points and other like points made of orthoquartzite cobbles. Chipping orthoquartzite is not easy by any stretch of one's skills as the late J. B. Sollberger, a superior flintknapper, learned; but those Woodland people found a way of doing it over many generations. Their approach to making Gary points of orthoquartzite differed from the hill country folks who made Castroville points. The geographic distribution of orthoquartzite Gary points maps the distribution of Woodland and Woodland related settlements in east and north-central Texas, linking technological style to a community's behavior, and from that to the geographic distribution of like groups.

WHY PRAIRIE CADDO MODEL DOES NOT APPLY

Site 41HM51 postdates the George C. Davis occupational sequence and has a solid Toyah lithic and faunal assemblage but with Caddo-style pottery rather than the thin bone-tempered Leon Plain ceramics. The time frame of the Toyah Phase occupation was determined to be the fifteenth century, after the onset of the Little Ice Age (A.D. 1300–1850). Here is my thinking on this subject. The Prairie Caddo Model was developed to explain the presence of early Caddo pottery in Central Texas as it related to the George C. Davis Site. The abandonment of the Davis Site ca. A.D. 1300 changed the dynamics of the Caddo settlements on the western fringe of their territories, and probably their relationships to Central Texas groups. The climate events brought about by the Little Ice Age, the corresponding ecological changes, the presence of bison in Central Texas, and plethora of groups migrating into Central Texas negate any relevance of the Prairie Caddo Model for 41HM51. Arnn's (2012) Tejas Alliance is more applicable to the region post A.D. 1300 in my opinion.

TEJAS ALLIANCE, BISON, AND TOYAH CLIMATE

Arnn (2012) has presented a detailed argument regarding the plethora of cultural groups in central Texas during the Toyah interval. The presence of bison was certainly an economic and subsistence magnet that attracted neighboring

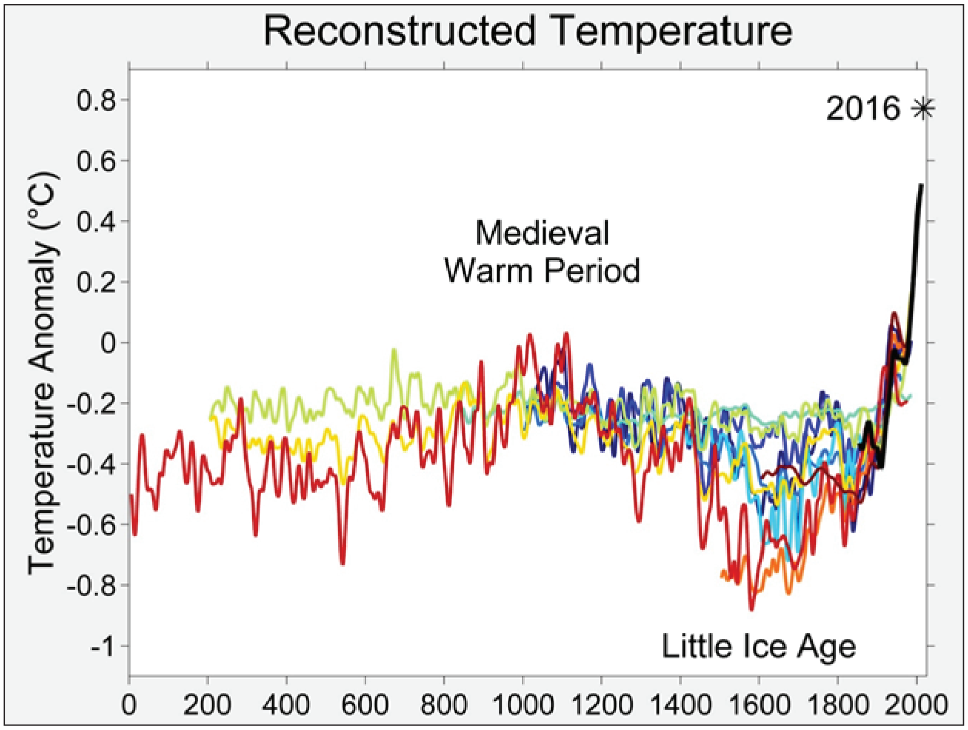

Figure 14.1. Temperature shown in relation to the Medieval Warm Period and Little Ice Age. These climate shifts apparently caused major changes in the subsistence agricultural and hunters and gatherers of Texas and elsewhere in the past 2,000 years. (From Wikipedia.com).

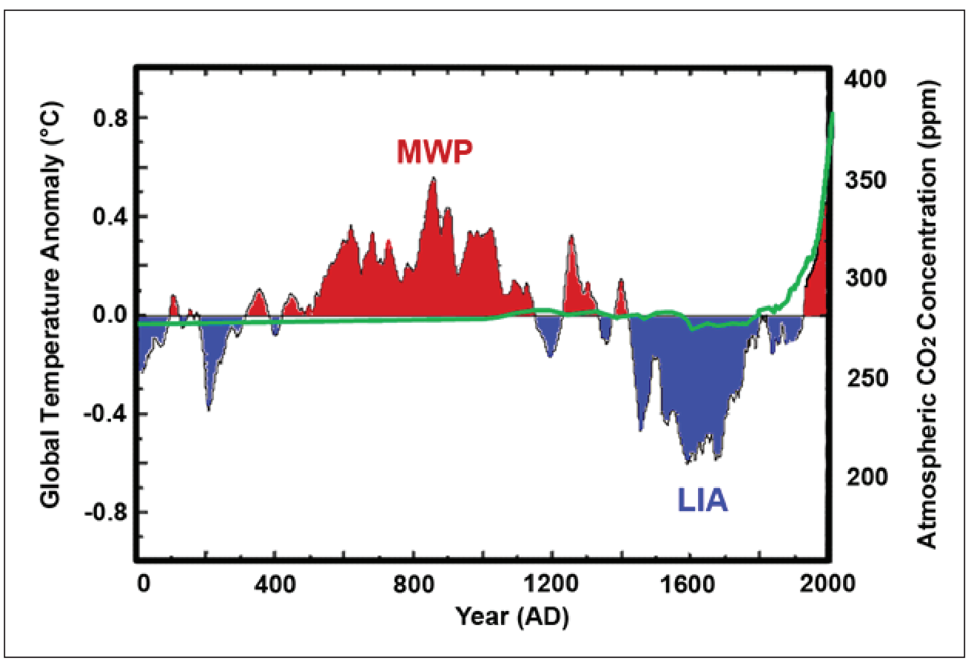

Figure 14.2. CO2 concentrations shown in relation to the Medieval Warm Period and Little Ice Age. (From CO2 Science).

groups to exploit this valuable resource. Climate during the Little Ice Age (**Figures 14.1** and **14.2**) was most likely responsible for the push-pull of the great bison herds. The climate during Medieval Warm Period (A.D. 800–1300) favored the development and expansion of agriculture across North America (Foster 2012). Great centers of culture such as Hohokam, Mimbres, Chaco Canyon, and Cahokia flourished during this climate interval. While the Medieval Warm Period was favorable for agriculture in the Southwest and Southeast, it may have been a period of severe drought in Central Texas.

The possibility of drought during the Austin Phase and Medieval Warm Period may be suggested by the incredible amount of *Rabdotus* shells in Austin Phase sites along Blackland Prairie and along the Balcones Edge in Bell, Coryell, and Williamson counties. I agree completely with Dr. Kenneth Brown (personal communication 2018) that *Rabdotus* was a food source and not incidental to anthropogenic soils. *Rabdotus* occur in arid and semi-arid regions of the state (Fullington and Pratt 1974). Whether the increased use of *Rabdotus* as a food source during the Austin Phase was due to drought in Central Texas during the Medieval Warm Period or food stress in which a third order food source was sought is unknown, but *Rabdotus* use seems to drop off in the Toyah interval. The absence of *Rabdotus* reported from 41HM51 may be telling. Either the snails were not available at the time of the 41HM51 occupation or that the occupants were not familiar with this potential food source, as *Rabdotus* are not indigenous to the more humid east Texas. If they were Caddo, they may not have been familiar with snails as a food source, but the occupants of 41HM51 did consume river mussels.

The shift from the Medieval Warm Period to the Little Ice Age had a dramatic impact on subsistence agriculture across the northern hemisphere (see Foster 2012). The Little Ice Age was not a single cold event, but rather constituted a series of very cold impulses that kept subsistence farmers in a very stressful situation. Four of five consecutive years of very cold temperatures shortened the growing season and caused repeated crop failures. Those societies that relied only on a narrow selection of cultigens were at the most risk, and those that diversified had a better chance of survival.

Significant ecological changes also occurred that dramatically impacted subsistence agriculturalists and put local hunters and gatherers on the more advantageous track. The southern shift of the great bison herds led to dramatic changes in the economic and social networks across Texas and elsewhere (Creel 1991; Ricklis and Collins 1994:17, 18). Perttula et al.'s (2014) research has shown that the Caddo increased their use of corn during the time of the Little Ice Age; they also sent hunting parties westward to harvest bison and deer. In other words, they diversified, and succeeded in surviving quite well. By contrast, Pueblo subsistence agricultural groups in the Southwest who had successfully farmed in the higher elevations during the Medieval Warm Period (A.D. 800–1150) abandoned their settlements due to shortened growing seasons and drought to seek alternative choices. They had no alternatives in their desert environment comparable to the Caddo. This population shift occurred with the Mimbres, Mesa Verde, and Chaco Canyon inhabitants who either drifted southward to lower elevations (Mimbres) or to the Rio Grande Valley after A.D. 1200 to get closer to bison or to those who had access to bison (e.g., Salinas Pueblos [Gran Quivira, Abo, Quarai], Taos, Pecos, and Jornada). The extreme drought in the Southwest between A.D. 1277 and 1293 also had something to do with the Ancestral Pueblo dispersion and population displacement elsewhere (Benson and Berry 2009).

When the bison moved southward into Texas during the Little Ice Age, the cultural dynamics and economic patterns changed across the southern Plains, Edwards Plateau, eastern Southwest, and Caddo. Bison were walking "Walmarts" and offered many resources not readily available during the Medieval Warm Period. Their presence brought marginal subsistence agriculturalists into Central Texas seeking alternatives or to diversify their subsistence economy. The hunters and gatherers of Central Texas, the Jumano and Suma of the Southwest and the South Plains, and others, were positioned more advantageously as the bison were already added to their reliable hunting and gathering economy. Furthermore, they had valuable commodities for trade in the form hides, jerky, pemmican, and Edwards chert.

The fluctuating temperature extremes during the Little Ice Age also may have resulted in bison adopting seasonally dispersed behavior and not a constant presence in any one area. Marginal animal husbandry was practiced by some groups on the coastal plain west of the Colorado River (which Joutel referred to as the Maligne River) by creating pasturage and driving bison from one group to another (see Foster 1998:172). In other words, sophisticated strategies were employed by some of the groups in the prairies to encourage bison to hang around.

SUMMARY

I agree with Prewitt that 41HM51 does not fit the Prairie Caddo model as originally proposed. Site 41HM51 is not comparable to what I proposed in the Prairie Caddo Model where Caddo or Caddo affiliated groups may have been living in the prairies at the time of the George C. Davis site occupation prior to the Little Ice Age. Simply put, the George C. Davis Site was abandoned by A.D. 1300. Also, the time difference between early and late Caddo would explain the absence of Gahagan knives and Bonham-Alba arrow points at 41HM51. However, I don't think the occupants at 41HM51 were affiliated with other Toyah communities either since no Leon Plain pottery was present. After all, the site is in the northern fringe of Toyah range. In my opinion, 41HM51 could be an indication of a hunting camp by Caddo speaking groups coming into Central Texas to hunt bison and deer as a means of diversifying their economy during the Little Ice Age. There are ethnographic accounts of Hasinai in Central Texas to hunt bison (Ricklis and Collins 1993:19). The pottery is telling in my opinion. The absence of bone-tempered Leon Plain, a classic Toyah marker, which is common in Toyah sites farther south and west, should not be ignored, and may indeed be an indicator of social identity. Caddo people could have been coming from the Neches, upper Sabine, or possibly western Caddo linguistic areas. The Wichita, Tawakoni, and Iscani, groups known to have been in in central and north central Texas and along the Brazos River in the eighteenth century (Bolton 1914; Castaneda 1939; Newcomb 1961). Newcomb (1961:248, 249) notes the Wichita may have migrated southward from Kansas, but their original homeland may have been in the Red River area. Perhaps they moved southward to reclaim their ancestral lands in north central Texas.

Caddo pottery was not the only thing at 41HM51 that was foreign to the region. Five flakes of Jemez Mountain (New Mexico) obsidian and an arrow point was also recovered from 41HM51 that may strengthen my suggestion that the site could have been a western Caddo (e.g., ancestral Wichita) hunting camp. Obsidian, turquoise, and Pueblo pottery is well documented in north central Texas sites (Crook and Perttula 2018), a region known to have in the Wichita territorial domain (Newcomb 1961, Map 3) and Caddo pottery (Ellis et al. 2015).

The occupants of 41HM51 could have been Hasinai. Ricklis and Collins (1994:19) make a good case for Hasinai presence in Central Texas. And the presence of Patton Engraved pottery at Rowe Valley (Rush et al. 2015) and Poynor Engraved from Mustang Branch Site (41HY209-T) adds support to that case. As Hegmon (1998) states, the relationship between material culture and social processes is a complex one. And the social makeup of native encampments in Central Texas in the eighteenth and early nineteenth centuries was equally complex (Ricklis and Collins 1993:17, 18). The bottom line is we do not know the identity of the folks that occupied 41HM51. They may have belonged to a single group or were among the multi-band coalitions. But whoever they were, they were either Caddo or in direct or indirect contact with some Caddo groups, perhaps at regional trading fairs, in order to obtain the pottery.

CONCLUSIONS REGARDING SHAFER'S ANALYSIS OF 41HM51

Shafer ultimately concludes, for various reasons, that the 41HM51 site assemblages are not applicable to his model. However, the exploration of this topic as a research trajectory still fulfilled the overall intent of the TxDOT research design. That intention was to utilize data from the site components to identify potential novel information about the study of prehistory in Central Texas, particularly the Terminal Prehistoric Period. Novel information was identified through the examination of the site in relation to the Prairie Caddo Model. Shafer identified three items of interest. First, Shafer's comments posit that the Terminal Prehistoric site occupants may not be Toyah. Rather, he suggests they may be Caddo affiliated. This is important because it is quite possible that the site's occupants may have been mischaracterized as Toyah when they were not. Secondly, Shafer emphasizes that the Terminal Prehistoric site occupants may have been agriculturalists who intensified hunting due to unstable climatic conditions in the Terminal Prehistoric. These unstable conditions supposedly generated shorter growing seasons caused by the Little Ice Age (ca. A.D. 1300–1850). Finally, Shafer concluded that his Prairie Caddo Model is only applicable to a very short period of three hundred years (A.D. 1000–1300). The generally accepted time span of the Austin Phase is A.D. 750–1250 and the Toyah Phase dates A.D. 1250–1750. The limited spatial and temporal parameters make it difficult for this model to be tested and therefore its utility could be questioned.

CHAPTER 15: THE COMPLETION OF THE TXDOT RESEARCH DESIGN SUMMARY AND CONCLUSIONS FOR 41HM51

The chapters in Part 2 of this report examined several topics including the potential extraction and use of bone grease at 41HM51, the relative mobility of the site's occupants, and whether the Prairie Caddo Model was applicable to the site. These topics are related to five hypotheses TxDOT proposed in its research design, which were outlined in Chapters 3 and 9. This chapter reviews the findings of the research and analyses undertaken to address the TxDOT research design and presents the significant findings which resulted from the research.

TxDOT HYPOTHESIS 1: THE TOYAH (TERMINAL PREHISTORIC) 41HM51 SITE OCCUPANTS ENGAGED IN BONE GREASE EXTRACTION BEHAVIOR

Bone grease is a base ingredient in pemmican, which was an important foodstuff in prehistory. Establishing that bone grease extraction behavior was occurring at a site would be the first logical step in arguing that pemmican was being produced at the site. Chapter 9 outlined several features and artifacts that survive in the archeological record can be used to determine if bone grease extraction was practiced by the site inhabitants. The cultural materials recovered from the Jayroe Site were compared against this list of features and artifacts to determine whether bone grease extraction was occurring at the site. In Chapter 10, it was established that the 41HM51 site contained nearly all these indicators. Therefore, Hypothesis 1 is supported. The Toyah (Terminal Prehistoric) site occupants of 41HM51 did engage in bone grease extraction behavior.

TxDOT HYPOTHESIS 2: DATA RELATED TO BONE GREASE EXTRACTION BEHAVIOR IS COMMON IN TOYAH PHASE ARCHEOLOGICAL SITES, BUT RARE IN AUSTIN PHASE SITES

This hypothesis was developed due to documented observations within Late Prehistoric archeological literature suggesting differences in the intensity of bone grease extraction during the Austin and Toyah phases (e.g. Thompson et al. 2012). A detailed examination of Central Texas Late Prehistoric data recovery reports was conducted and presented in Chapter 11. A total of 38 sites with 52 temporal components were examined in relation to the series of criteria developed in Chapter 9, which were determined to be indicative of bone grease processing. The results were compared between the Austin Phase and Toyah Phase components as identified in the literature.

Twenty-eight of the site components were identified as Austin or Toyah Phase. Of these 28 separable Austin and Toyah Phase components, 11 were Austin Phase and the remaining 17 were Toyah Phase. Twenty-seven percent of the Austin Phase components contained evidence of bone grease extraction and 41 percent of the Toyah Phase components had evidence of grease processing. Therefore, the hypothesis was supported by the data reviewed.

However, there are some caveats associated with the results of the analysis. First, this conclusion is based solely on the quality and detail of the data in the archeological documentary record. Written reports have varying levels of detail, objectives, and points of focus. Second, the sample, although containing most of the available sources for comparison, is small, containing a total of 28 Austin and Toyah components. Therefore, these results represent only a fraction of the total number of known Toyah and Austin occupations in Central Texas. These results identify a trend, however, this trend requires additional validation before it is accepted as more than a preliminary finding. As more data for both Austin Phase and Toyah Phase archeological sites becomes available, future researchers can build on this research. In addition, this endeavor resulted in the observation that bone grease extraction was likely occurring during all periods of prehistory including the Paleoindian and Archaic periods.

Of note, the Austin Phase dates from A.D. 750 to 1250. According to the graph provided by Shafer in Chapter 14, the majority of the Austin Phase was influenced by the environmental conditions of the Medieval Warm Period (A.D. 850–1200). Warmer temperatures and dryer conditions during this period could have resulted in less dense populations in Central Texas, explaining the relatively scarcity of Austin Phase occupations compared to the subsequent Toyah. The warm period would have provided longer and more productive growing seasons for the agriculturalists located on the peripheries of Texas. The warmer climate may have also negatively affected the production of pemmican in that hotter summers would have led to more rapid spoilage, though grease processing may have continued for immediate dietary purposes or non-dietary uses. In addition, the milder winters would have enabled hunter/gathers more opportunities to obtain wild foods, while the harsher winters of the following Little Ice Age (A.D. 1450–1650) would have stifled that opportunity and necessitated food provisioning for winter.

TxDOT HYPOTHESIS 3: THE PRIMARY REASON FOR THE EXTRACTION OF BONE GREASE AT 41HM51 WAS TO USE IT AS A COMPONENT IN THE PRODUCTION OF PEMMICAN

The exploration of Hypothesis 1 in Chapter 10 established that bone grease extraction behavior was a significant activity occurring on the site. The next step in the TxDOT research design was to investigate whether or not the bone grease extraction occurring on the site was related to pemmican production or other activities. The hypothesis would be supported if the production of pemmican was predominant in the ethnohistoric and ethnographic literature and if there was evidence from the archeological data from the site supporting pemmican production. If these conditions were not met, the production of pemmican as the primary use of bone grease at the site would not be supported. TxDOT proposed a research strategy for addressing this question, which included a review of ethnographic and ethnohistoric literature, examination of site features and artifact assemblages, and residue analysis of groundstone, ceramics and other lithic tools.

The results of the ethnographic and ethnohistoric review resulted in the identification of a total of 65 instances of bone grease extraction behavior associated with 27 indigenous cultural groups. The ethnographic and ethnohistoric review supports the hypothesis. However, the ethnographic literature does suggest that bone grease had an extensive range of uses (see below). A connection between grease extraction and pemmican production is clear, however, the prevalence of pemmican in the ethnohistoric record may be in part due to bias based on the background and/or interests of the recorder (e.g. explorers/traders versus anthropologists) and the amount of time they spent with a given group. For example, recorders with longer exposure to a group may record a wider range of activities than others, and traders or explorers may be more interested in potential provisions and trade goods instead of other foodstuffs.

A review of the archeological features and assemblages demonstrated a highly fragmentary faunal assemblage, cooking features, and a wide range of lithic and groundstone tools. Additionally, meat and fat residues were identified on groundstone artifacts and ceramics. According to the criteria outlined in the TxDOT research design, the primary reason for the extraction of bone grease at 41HM51 was to use it as a component in the production of pemmican.

Other revelations relevant to site interpretation, particularly in the Terminal Prehistoric, were revealed during this phase of the investigations. One such revelation was that bone grease was used for a multitude of purposes beside pemmican production, and that bone grease may have served as a utilitarian staple resource for many activities simultaneously (see Chapters 9 and 12). It is very likely that the bone grease extraction occurring at 41HM51 was producing grease for a range of dietary and non-dietary applications, including but not limited to pemmican.

One issue regarding pemmican production in Central Texas would be that the summer heat may affect the shelf-life of pemmican and therefore it would not be a viable long term, storable food source. However, experimentation to determine the stability of pemmican at various temperatures has yet to be performed. Therefore, having no experimental data for comparison, any suggestion that pemmican would not last through the hot Texas summer is still only an assumption. However, as pointed out in Shafer's comments regarding the site and his Prairie Caddo Model (see Chapter 14), the Terminal Prehistoric Period may have been much cooler during the Little Ice Age than the modern climatic regime. Pemmican may spoil during the current warmer weather. However, the cooler climate during the Late Prehistoric would have been more conducive for pemmican preservation for provisioning. Pemmican may have been a winter provision that Late Prehistoric peoples in Central Texas utilized to survive the harsh winters during the Little Ice Age.

TxDOT HYPOTHESIS 4: THE SITES LITHIC ASSEMBLAGE SUGGESTS THAT THE SITE'S TOYAH PHASE OCCUPANTS ENGAGED IN VERY LIMITED MIGRATORY BEHAVIOR

This hypothesis sought to gain insight into how far the Terminal Prehistoric site occupants traveled within the region. Did they travel dozens, hundreds, or thousands of miles while engaging in their hunting and gathering lifestyle? To learn more about this question, TxDOT proposed that if the site inhabitants engaged in a large geographical range of movement, they would have had access to a wider variety of raw chert sources with distinctive differences in their chemical composition.

The analysis of the lithic assemblage using UVF conducted by Prewitt resulted in the observation that the majority of stone obtained from the site was local in origin and was likely acquired within the vicinity of the Leon River Drainage Basin. According to the results of the Prewitt study, the vast majority of chipped stone artifacts were produced from stone originating from the vicinity of the Leon River Valley, which supports Hypothesis 4 (see Chapter 13).

This hypothesis established that the site occupants were limited in their travels across the state. However, non-local artifacts were recovered from 41HM51. These include obsidian generated from New Mexico located 600 miles west and Caddoan Pottery from approximately 200 miles east of the site. One viable explanation explaining their presence would be trade. There is no direct evidence for the trading materials produced at the site. However, the site occupants would have traded something for these exotic items. Most likely they were trading many things including hides, chert, bone grease, jerky, and possibly pemmican.

One caveat may be the fact that there are fewer and fewer chert sources moving east from the Edwards Plateau. Although the UVF analysis confirmed that the site occupants most likely did not physically travel west beyond the Edwards Plateau, it does not establish how far east they traveled. They could have traveled into Caddo Lands. This is a definite possibility, especially since Caddoan type pottery was recovered on the site.

TxDOT HYPOTHESIS 5: THE ARTIFACTS FROM THE SITE'S TOYAH PHASE CAN BE USED TO TEST SHAFER'S PRAIRIE CADDO MODEL

Site 41HM51 is located on the Leon River in Central Texas and dates to the Late Prehistoric. Shafer's Prairie Caddo Model (2006) also relates to the Late Prehistoric and includes the Leon River Drainage. Based upon this overlap, TxDOT recommended that Shafer's model merited consideration during the interpretation of 41HM51. TxDOT contacted Harry J. Shafer to compare his model with the 41HM51 site components and contribute to a chapter for this report to address Hypothesis 5 (Chapter 14). Shafer ultimately concludes that the 41HM51 site assemblages are not applicable to his model, refuting this hypothesis. However, the act of addressing this question opened other avenues of research, including questions about cultural identity within different geographic areas in the Terminal Prehistoric Period in Texas. Shafer's analyses revealed that the site's Terminal

Prehistoric occupants may have been mischaracterized as Toyah when they could have been Caddo or Caddo associated peoples. He also pointed out that the climatic anomaly labeled as the Little Ice Age may have influenced agriculturalists to adapt to adverse conditions by adopting a hunter and gathering way of life. Finally, the fact that the Shafer's contention that the model does not apply to the Terminal Prehistoric site components may bring into question the utility of the model.

SUMMARY OF TxDOT HYPOTHESES TESTING

Investigations addressing the five hypotheses proposed by TxDOT were successful. This success can be attributed to the feasibility studies conducted early on in site analysis. These studies informed researchers about the quantity and quality of data available in the site's assemblages. Conducting feasibility studies early on in the interpretive process is highly recommended.

Bone grease extraction and pemmican production were likely occurring at Site 41HM51 during the Terminal Prehistoric, and bone grease processing was a relatively common occurrence in Terminal Prehistoric sites. Additionally, UVF analysis of the lithic assemblage determined that the range of mobility of the site occupants was smaller than one might expect due to the presence of Caddoan ceramics and obsidian from New Mexico in the site assemblage. Even though the Prairie Caddo model could not be applied to the Terminal Prehistoric site assemblage, Shafer's review of the site provided useful information which appears to support suppositions relating to the effect of climatic changes on subsistence and settlement patterns in Central Texas and the surrounding regions during the Austin and Toyah Phases.

The results of the analyses associated with TxDOT's five hypothesis demonstrated that the Terminal Prehistoric occupation at Site 41HM51 was much more complicated than what could be discussed and proven by focusing on pemmican production alone. Unfortunately, most of the archeological residue from that occupation, especially the more fragile organic constituents such as wood, leather, and other plant material, has been lost to time. However, the residue that remains could best be explained in terms what is available for examination. Climatic changes causing changes to available resources and subsistence strategies, which likely included pemmican production, are likely the most obvious mechanism for steering an explanation of what was recovered at the site.

The implementation of the TxDOT research design successfully facilitated the illustration of the site's eligibility for listing on the NRHP under Criterion D. New information about the prehistory of Central Texas has been generated through this analysis, as have potential avenues for additional research.

THE ADDITIONAL FAUNAL ANALYSIS

There were a number of contributions to our understanding of the Terminal Prehistoric Period in Central Texas gained from the re-analysis of the site's faunal remains by Jodi Jacobson Ph.D (see Appendix J). The work of Jacobson and her team confirmed that bone grease extraction was in fact a significant activity that was occurring on the site. Jacobson's analyses also revealed that prehistoric site occupants would know in advance the quality of the bone grease in fresh bone and therefore would not pursue bone grease from emaciated, pregnant, or diseased animals. Additionally, just because there are a few intact long bones with complete epiphyses, does not preclude bone grease extraction.

One additional revelation uncovered by Jacobson's analyses was that there were carnivore teeth marks on an inordinate amount of bone fragments. Comparison with other sites' faunal assemblages revealed that this robust sample could not be due to wolves, bears, or coyotes. This led to the conclusion that domesticated dogs or jubines were present at the site. The human site occupants were likely using domesticated dogs for hunting and hauling loads such as bison and deer meat back to camp during hunting forays and possibly while moving camp.

Another important fact learned was that the boiling of pulverized bone to extract bone grease degrades the bone fragments making them appear older and weathered to the untrained eye, which was something noted by Outram (2002a) while acknowledging the lack of utility in applying the FFI to questions relating to bone grease extraction. Jacobson's analysis spotlights the misuse of the FFI when applied to confirm the presence or absence of bone grease extraction in Prewitt's faunal analysis (see Chapter 5). The results of this analysis confirmed that all faunal analyses should utilize appropriate methods and be conducted by a qualified faunal analyst. Finally, Jacobson's faunal analysis is a wealth of information for comparison with other faunal assemblages and will undoubtedly be mined for information by future researchers.

CONCLUSIONS

The data recovery conducted at 41HM51 yielded a plethora of novel information about the Terminal Prehistoric Period in Central Texas. This includes acknowledging the success of conducting feasibility studies early on in the process to obtain a sense of the quality and quantity of the data within the site assemblages. These studies were built on by proposing research trajectories that could be addressed by the recovered site data.

Bone grease extraction was a significant activity for Terminal Prehistoric Period people. Bone grease could be used for purposes ranging from pemmican production to making paint, curing hides, insect repellant, and ointments. This study determined that pemmican was likely being produced by the 41HM51 site occupants using stones to grind up dried meat. Although there is little direct evidence that pemmican was specifically traded, it is likely that the site occupants were trading hides, chert, jerky, and possibly pemmican for exotic items like obsidian and/or pottery. Research also determined that bone grease extraction was occurring throughout prehistory in Texas.

This study determined that not all Terminal Prehistoric occupations in Central Texas are classic Toyah. Due to the presence of Caddoan pottery, it is just as likely that the 41HM51 site occupants were Caddo associated and that the site may have been mischaracterized as Toyah. They could have just as easily been Caddo related agriculturalists forced back out onto the plains to hunt due to a cool climatic shift creating shorter growing seasons.

This research can be built upon by future researchers. A future hypothesis that may be tested could be that the Toyah phenomenon can be explained as the presence of agriculturalists living on the periphery of Texas being forced out onto the plains to hunt in order to survive the shorter growing seasons associated with the Little Ice Age. In summary, the implementation of the TxDOT research design provided a viable explanation for the formation of the site's artifact assemblages. It also clearly illustrates the eligibility of the site for listing on the NRHP, and the interpretation of the site provides a detailed illustration of the day to day behavior of Terminal Prehistoric peoples within Central Texas.

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Part III

APPENDIX A: Analysis of Vertebrate Faunal Remains from 41HM51, Hamilton County, Texas

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May 16, 2014

Doug Boyd and Karl Kibler
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RE: Faunal Analysis for 41HM51
Deliverables = Paper Encoding Forms, Electronic Database, and Letter Report

Dear Doug and Karl:

As per the consultant agreement, I have completed the faunal analysis of the bone specimens from prehistoric site 41HM51 provided by Prewitt and Associates, Inc. As stated in the scope of services, I have identified the specimens to the lowest taxonomic level possible, as well as element, portion, symmetry, size range, the presence or absence of burning, and cultural modifications (i.e., cut marks). The requested attributes (with input from Karl prior to the start) have been recorded on paper forms (see attached) and subsequently entered into a Microsoft Excel spreadsheet (see attached). Following identification, specimens were bagged according to taxon, maintaining lot number and provenience information (via original Prewitt tag with additional bags designating the different species placed inside the original bag). A small paper tag with the species name was included for each species with the bones identified, within a small tag bag. All paper tags are separated by a tag bag to prevent contact with the bones, as required by curation facilities.

My overall impression of the faunal assemblage is that the bone was highly processed. Initially, bones were broken for marrow extraction, followed by smashing for bone grease processing (i.e., boiling). This type of intensive processing of bones and the diverse species represented reflects a lengthy campsite activity as compared to a kill site or primary processing area. The analysis of the size of the pieces documents that a very high percentage of the bones are quite small (less than 3 cm in length). This dominance of small pieces likely reflects smashing bones with the probable intent of boiling them to extract bone grease. The high percentage of small pieces, combined with multiple species of different sizes identified, as well as overlapping body sizes by species (i.e., deer and pronghorn), made identification and assignment of the small pieces very difficult. Most pieces are midshaft fragments or otherwise lack sufficient diagnostic characteristics (specifically the proximal or distal ends) to confidently assign those pieces to specific species, and sometimes not even into a general size category (such as deer size).

Therefore, the high fragmentation index, combined with the subsequent lack of diagnostics, rendered a very high percentage of the overall assemblage indeterminate.

The identification of multiple species in this assemblage documents a varied subsistence base for this population, such as Dering (2008) has documented for other Toyah components in Texas. The list of species is relatively long and includes: bison (*Bison bison*); deer (*Odocoileus virginianus*); pronghorn (*Antilocapra americana*); jackrabbit (*Lepus* sp.); cottontail (*Sylvilagus* sp.); squirrel (*Sciurus* sp.); raccoon (*Procyon lotor*); turtle (Testudines); bird (Aves); fish (Osteicthyes); and dog/coyote (*Canis* sp.). A few snake (Serpentes) vertebrae and many tiny rodent (Rodentia) bones are also present, but I believe these are likely intrusive and not part of the cultural subsistence base. It is likely that these small underground-dwelling rodents represented by the bones are also the rodents responsible for the gnawing/chewing marks on the bones.

Because many different species are represented and most pieces lacked the proximal and/or distal ends or critical characteristics, most pieces were assigned to size classes such as bison size, deer size, rabbit size, etc. In the case of deer size this could be either deer or pronghorn as both are similar in body size and positively identified in this assemblage. The pieces identified as bison size are most likely bison as the documented age of this assemblage does not support that similar size modern cow would be present and no modern cow elements were positively identified.

The assemblage also reveals spotty, dark staining on a high percentage of the pieces. The staining is most likely a manganese oxide from the depositional environment. Although not cultural in nature, this black staining made it difficult to tell if some of tiny pieces were actually burned black or if they were just stained a dark color by the manganese. Another noncultural alteration was from rodents with small teeth that left gnawing/chewing marks of parallel grooves with flat bottoms on many pieces. These chewing marks occur along margins of many bones, and in a few instances caused considerable modification to the shape of the original bone. These teeth marks may be similar to cut marks in some instances, but for the most part there are distinct visual differences, observable upon close examination. The major differences are the teeth marks are much larger than the very fine, shallow cut lines made by very thin stone cutting tools, which are nearly impossible to see with the naked eye. Size and shape are obvious characteristics that separate these two modifications.

Cultural modifications to the bones included burning (changing the color of the original pieces to black, white, gray, brown or a combination of these colors) with the color dependent on the temperature(s) each piece was subjected to. It is my interpretation that this burning is most likely the result of discard into a fire, which often reduces the bone to even smaller pieces. Very few large pieces exhibit any major burned area that is black or white in color indicating higher temperatures or longer duration. However, I did notice that at least a few of the larger bison long bones (e.g., #600 and #677) showed concentrated/limited areas of midshafts lightly burned to a light brown color and the area immediately surrounding exhibits flaking of the cortical tissue. I have seen this same manifestation on bison bones in other assemblages, and have interpreted this light burning and flaking to indicate that heat was applied to greenbone. The heating hardened/dried the bone slightly, causing the removal of the periosteum tissue in that area, thus promoting easier breakage of the thick green bone with hard hammer percussion instruments.

Other cultural modifications include spiral fractures on many bones, a few recognizable impact scars from hard hammer percussion on midshafts, plus many tiny cut marks on bison bones, deer and dog size pieces, bird bones, and some others. Nearly all cut marks are very thin lines, very shallow, and quite difficult to see without at least a 10x hand lens. Cuts are distinguishable from rodent teeth marks as they are usually very thin single lines, often in clusters, with narrow "v" shaped bottoms, unlike the two parallel grooves caused by rodent incisor teeth. The cultural cuts are present on bison long bones, ribs, phalanges, and spines. Cuts on deer size pieces are present on ribs, long bones, and pelvic pieces. No specific cut marks could be linked to skinning the animal. Therefore, these cuts were likely created via stripping the meat from the bones and in a few instances disarticulation of sections of the animal. Based on the size of the short, thin cut lines, the projected tool to have caused these would likely have been sharp flakes and not thick biface edges.

A few bone pieces have rounded/smoothed edges (e.g., #235, #274, #283, #472, #499, and #545). This rounding is interpreted as reflective of water transport or passage through the digestive system of an animal. Only high-powered microscopic examination may help distinguish which caused the rounding. This is only present in a very small percentage of this assemblage, and does not indicate a water transported assemblage that is out of context.

Not all pieces were highly fragmented, as some small bones such as the phalanges, sesamoids, carpals, and tarsals are still intact/complete. Not all distal or proximal ends of long bones (from both deer and bison) were completely smashed or targeted for bone grease, as a few recognizable ends are still intact. At least nine proximal and distal ends of bison bones are still intact.

For identified bison elements, nine intact proximal and distal ends were expeditiously measured with electronic calipers. Obtained measurements were compared to known measurements from male and female bison elements presented by Speth (1983). This comparison of measurements indicated at least two mature males (two left distal metatarsals, #372 and #693) and two females (two right proximal radii, #677 and #716) are represented. At least one likely newborn bison is represented by a metapodial (#461). A few fetal bison fragments are also present (e.g., #623 and #662), which would indicate that one female was pregnant with at least one unborn bison. Consequently, bison MNI is five (5) with roughly equal numbers of male and female. Counts of proximal and distal ends of bison reflect at least four mature individuals thus supporting the MNI count. Based on one likely newborn (a few days old) bison metapodial and the few other fetal bone fragments, I project the season of occupation to be approximately April. Only a few bison vertebrae, and two bison molar teeth were present. No obvious cranial parts, major mandible sections or pelvises were recognized. These are very bulky parts with little meat, and likely an indication that bison were predominately killed, skinned, and disarticulated off-site with only certain portions, such as legs, hump, and rib cage returned to the camp for intensive processing.

For the identified deer, initial counts of identified right and left sides, proximal and distal ends, provides MNI of three (3) individuals, as at least three right distal radii, three right immature tibia, and three immature calcaneum are represented. At least one deer skull fragment has attached antler, which indicates at least one male with an unshed antler. Multiple antler fragments are present, however, most are small antler tips so it was not possible to tell if those pieces were shed or attached. A number of deer mandible and maxillary sections and loose deer teeth are present, which may indicate three or more animals of different ages. Some deer teeth/maxillary sections appear from individuals young enough to attempt age determination. Teeth and mandible sections help determine the overall number of individuals represented, but only the really young deciduous premolars are suitable for providing a narrow period of death, and thus the season of occupation. Initial examination of tooth rows indicates that at least one deer was likely between 10 to 15 months old, based on the presence of heavily worn deciduous premolars with three cusps, and erupted M3. Another maxillary section indicates an older individual with worn molars. It appears at least one young and one older deer are represented, one being a male. One articulated deer foot (#726) is represented. Again, most deer and deer size pieces reveal similar intensive processing (smashing for marrow extraction and bone grease processing), with a limited number of intact proximal and distal ends. Based on the elements represented (i.e., skulls, vertebrae, phalanges), the entire deer carcass was brought to this camp for processing.

Positively identified pronghorn pieces are very few in number, with only one tooth (molar #481) and one third phalange (#652) positively identified, for MNI of one (1). It is likely that a number of the deer sized fragments represent pronghorn, but lacking intact diagnostic ends, it was not possible to specifically identify fragments as this species. Given the presence of these two identified elements, these support an interpretation that the entire carcass was brought to camp for processing, the same strategy used for the deer.

Raccoons are minimally represented by two different size mandibles (#558 and #252). Therefore, MNI is two (2). Few other elements of this species were recognized.

Rabbit bones are not as well-represented as one might expect. Jackrabbit (e.g., #200, #412, and #658) and cottontail (#42) are definitely present. Most rabbit sized pieces could not be specifically identified to which type of rabbit.

Fish bones are relatively numerous (. Catfish is definitely identified here by dorsal spines (i.e., #17, #317, and #599), the mouth area (#294, #298, #604, and #680), and likely at least a few very large vertebrae (#i.e. #323 and #465), which compare favorably with catfish. One fish vertebra is 12-13 mm in diameter and represents a relatively large catfish. A few small vertebrae from an unidentified fish(s) are also present. A fish otolith is also present (#445, white and broken in half). It may be identifiable. Multiple fish are likely represented.

Turtle pieces are also quite numerous. Most are small fragments of the carapace. Their highly fragmented nature would indicate that these pieces were also subjected to processing, possibly boiling. At least a few pieces are burned (e.g., #310, #481, #488, #498, #599, #670, and #706).

Bird bones identified include at least three sizes of birds: one large turkey size (e.g., #94, #363, #345, and #585); one duck size; and one smaller than duck (#439). At least three turkey size pieces (#94, #345, #363 and #585) exhibit tiny cut lines and spiral fractures. This supports utilization by the site occupants.

During the analysis, each bone piece was observed and a few new worked pieces were discovered. These were pulled from the general bone bag and placed in a separatebag with a new completed provenience tag and then grouped with the other modified bones. Two worked pieces (#295 and #692) eached revealed a grooved and snapped end, although the species could not be identified.

In going through each bag, a number of non-faunal items (i.e., flakes and pottery) were encountered. These items were pulled and rebagged and a paper tag with the provenience information was placed in the new bag. These small bags were then placed into one large grouping bag together. A few noncultural pieces (i.e., rocks, wood, calcium carbonate, and snail shells) were also removed from the bone bags.

The heavy fraction bone is quite small. I did not spend much time on these as it takes considerable time under the microscope to identify the tiny elements, and most often species cannot be determined. However, I did see burned deer antler fragments (#134), tiny fish vertebrae and skull parts (#139), tiny snake vertebrae (#139), rodent bones, and a turtle leg bone (#139) in the heavy fractions. Many tiny bones appear black at first glance, but with the manganese coating on present on the larger pieces in the assemblage, it is nearly impossible to state for certainty that these tiny fragments were burned rather than similarly discolored. Given the tiny nature and the very light weight of these pieces it is difficult to know if all these fragments are culturally derived or if some may have been deposited via alluvial deposition/water displacement.

Manipulation of the analysis Excel files can provide summary data to answer specifics as desired, such as counts and weights of different species represented. Querying the Excel files will allow quantifiable analyses of the raw data beyond the overview presented above.

In general terms, I felt very rushed to get through the basic identifications, recording, bagging and tagging of this assemblage in the time/budget allocated. I did contribute some of my own time to identify a few of unknown pieces. The bagging, tagging, and handling the different species, as per curation guidelines, is very time consuming.

If you have other questions, I will try to address them. Thank you for allowing me to conduct this faunal analysis for Prewitt and Associates, Inc. Please let me know if I can be of assistance in the future.

Sincerely,

TRC

Mike

J. Michael Quigg
Faunal Analysts

TRC 212273:~~;~~ Faunal analysis for 41HM51:~~;~~ paper documents, Excel file, ~~&~~ and letter report with observations.

Appendix A. Vertebrate Faunal Remains

Lot #	Unit	Elevation	Feature	Qty	Wt (g)	Taxon	Species	Element	Age	Portion	Side	Size, 0-3 cm	Size, 3-6 cm	Size, 6-9 cm	Size, 9-12 cm	Size, >12 cm	Burned (Color)	Cut Marks (Type)	Comments
133	TU 9	98.71-98.67	3	13	0.1	Rodent	-	Mandible	-	Medial	-	13	-	-	-	-	-	-	-
134	Feat. 4 (flotation)	98.49-98.39	4	50	11.8	Deer	-	Antler	-	Medial	-	50	-	-	-	-	50 white	-	-
134	Feat. 4 (flotation)	98.49-98.39	4	1	0.4	Deer	-	Antler	-	Tip	-	1	-	-	-	-	1 white	-	-
135	Feat. 4 (flotation)	98.49-98.39	4	35	10.4	Deer	-	Antler	-	Medial	-	35	-	-	-	-	35 white	-	-
136	TU 8	98.29-98.19	5	1	20.1	Deer	-	Humerus	-	Distal	L	-	1	-	-	-	-	-	weathered
136	TU 8	98.29-98.19	5	1	5.2	Deer	-	Axis	-	Medial	-	-	1	-	-	-	-	-	-
136	TU 8	98.29-98.19	5	3	2.5	Deer size	-	Long bone	-	Medial	-	3	-	-	-	-	3 black/ brown	-	-
136	TU 8	98.29-98.19	5	119	7.4	Indeterminate	-	-	-	Frags	-	119	-	-	-	-	4 white	-	-
136	TU 8	98.29-98.19	5	1	2.3	Indeterminate	-	Long bone	-	Medial	-	-	1	-	-	-	-	-	-
137	TU 8	98.26-98.19	6	30	0.3	Indeterminate	-	-	-	Frags	-	30	-	-	-	-	2 black	-	-
138	TU 10	98.29-98.19	6	72	0.6	Indeterminate	-	-	-	Frags	-	72	-	-	-	-	2 black	-	-
139	TU 8	97.71-97.68	7	15	0.2	Indeterminate	-	-	-	Frags	-	15	-	-	-	-	2 white	-	-
126	TU 17	97.82-97.61	8	1	26.9	Bison size	-	Long bone	-	Medial	-	-	-	-	1	-	-	-	1 spiral fractured, dark stained
140	TU 16/17 (Feat. 8 flotation)	97.82-97.61	8	1	2.0	Deer	-	3rd Phalange	-	Complete	-	1	-	-	-	-	-	-	-
140	TU 16/17 (Feat. 8 flotation)	97.82-97.61	8	1	0.5	Deer size	-	Sesimoid	-	Complete	-	1	-	-	-	-	-	-	-
140	TU 16/17 (Feat. 8 flotation)	97.82-97.61	8	24	7.3	Indeterminate	-	-	-	Frags	-	23	1	-	-	-	-	-	-
140	TU 16/17 (Feat. 8 flotation)	97.82-97.61	8	107	25.8	Deer size	-	Rib	-	Medial	-	107	-	-	-	-	gray/black/ brown	-	-
745	EU 13/14 (Feat. 10 flotation)	98.69-98.59	10	53	2.1	Indeterminate	-	-	-	Frags	-	53	-	-	-	-	2 white, 1 black	-	-
746	EU 13/14 (Feat. 10 flotation)	98.63-98.52	10	27	0.4	Indeterminate	-	-	-	Frags	-	27	-	-	-	-	-	-	-
747	EU 13/14 (Feat. 10 flotation)	98.63-98.52	10	28	0.5	Indeterminate	-	-	-	Frags	-	28	-	-	-	-	-	-	-
713	EU 44/45	97.83	11	1	55.6	Bison	-	Rib	-	Medial	-	-	-	-	-	1	-	-	-
714	EU 44/47	97.79-97.78	11	2	60.6	Bison	-	Rib	-	Medial	-	-	-	1	-	1	-	-	-
715	EU 44/47	97.81-97.82	11	9	19.7	Bison size	-	Rib	-	Proximal	-	8	-	-	-	1	-	8	weathered
716	EU 48	97.81-97.78	11	1	144.3	Bison	-	Radius	-	Proximal	R	-	-	-	-	1	-	-	spiral fractured, no cuts
717	EU 47/48	97.78	11	2	102.3	Bison	-	Rib	-	Medial/ Proximal	-	-	-	-	-	2	-	-	-
718	EU 46	97.78	11	1	12.9	Bison size	-	Rib	-	Medial	-	-	-	-	1	-	-	-	-
719	EU 48	97.78	11	5	34.2	Bison size	-	Rib	-	Medial	-	3		1	-	1	-	3	-

Appendix A, continued

Lot #	Unit	Elevation	Feature	Qty	Wt (g)	Taxon	Species	Element	Age	Portion	Side	Size, 0-3 cm	Size, 3-6 cm	Size, 6-9 cm	Size, 9-12 cm	Size, >12 cm	Burned (Color)	Cut Marks (Type)	Comments
720	EU 47	97.78-97.79	11	3	28.8	Bison size	-	Rib	-	Medial	-	-	-	-	1	2	-	cuts	rodent chewed
721	EU 47	97.78-97.76	11	7	57.8	Bison size	-	Rib	-	Medial	-	-	3	1	2	1	-	-	weathered
722	EU 48	97.75-97.77	11	11	11.3	Bison size	-	Rib	-	Medial	-	7	4	-	-	-	-	2 thin	-
722	EU 48	97.75-97.77	11	1	12.9	Deer	-	Calcanium	Immature	Complete	R	-	-	1	-	-	-	-	-
723	EU 48	97.77	11	1	3.8	Deer	-	Tooth, M1	young	Complete	L	1	-	-	-	-	-	-	-
725	EU 48	97.80	11	1	1.2	Fish	-	Vertebra	-	Complete	-	1	-	-	-	-	-	-	large
748	EU 44/45/47/48 (Feat. 11 flotation)	97.75-97.83	11	108	2.0	Indeterminate	-	-	-	Frags	-	108	-	-	-	-	3 black	-	-
748	EU 44/45/47/48 (Feat. 11 flotation)	97.75-97.83	11	1	0.1	Fish	-	Vertebra	-	Complete	-	1	-	-	-	-	-	-	-
748	EU 44/45/47/48 (Feat. 11 flotation)	97.75-97.83	11	2	0.2	Turtle	-	Femur	-	Complete	-	1	-	-	-	-	-	-	-
749	EU 28 (Feat. 12 flotation)	98.11-97.92	12	96	0.6	Indeterminate	-	-	-	Frags	-	96	-	-	-	-	-	-	-
749	EU 28 (Feat. 12 flotation)	98.11-97.92	12	2	0.1	Snake	-	Vertebra	-	Complete	-	2	-	-	-	-	-	-	-
470	EU 85	97.80-97.7	13	1	13.0	Deer	-	Radius	Mature	Proximal	R	-	-	1	-	-	-	4 thin	butchered, spiral fractured
470	EU 85	97.80-97.7	13	2	14.5	Deer size	-	Long bone	-	Frags	-	-	1	1	-	-	-	-	-
470	EU 85	97.80-97.7	13	2	3.7	Deer size	-	Rib	-	Frags	-	1	-	1	-	-	-	-	-
750	EU 85 (Feat. 13 flotation)	97.80-97.70	13	97	2.3	Indeterminate	-	-	-	Frags	-	97	-	-	-	-	2 white, 1 black	-	-
751	EU 145/153 (Feat. 14 flotation)	97.62-97.55	14	63	1.3	Indeterminate	-	-	-	Frags	-	63	-	-	-	-	-	-	-
751	EU 145/153 (Feat. 14 flotation)	97.62-97.55	14	4	0.3	Snake	-	Vertebra	-	Complete	-	3	-	-	-	-	-	-	-
726	EU 96/97	97.56	15	3	1.3	Deer	-	Sesimoid	-	Complete	-	3	-	-	-	-	-	-	-
726	EU 96/97	97.56	15	1	0.2	Deer	-	Due claw	-	Complete	-	1	-	-	-	-	-	-	-
726	EU 96/97	97.56	15	300	74.1	Deer	-	Skull	-	Frags	-	288	12	-	-	-	-	-	-
726	EU 96/97	97.56	15	7	31.7	Deer	-	Antler	-	Frags	-	4	1	1	1	-	-	-	-
726	EU 96/97	97.53	15	17	35.6	Deer	-	Mandible	young	Medial	R	12	4	1	-	-	-	-	P3 present, teeth good shape
726	EU 96/97	97.55	15	2	3.1	Deer	-	3rd Phalange	-	Complete	-	2	-	-	-	-	-	-	-
726	EU 96/97	97.55	15	2	6.2	Deer	-	2nd Phalange	-	Complete	-	-	2	-	-	-	-	-	-
726	EU 96/97	97.55	15	2	9.5	Deer	-	1st Phalange	-	Complete	-	-	2	-	-	-	-	-	-
726	EU 96/97	97.55	15	1	0.4	Deer	-	Sesimoid	-	Complete	-	1	-	-	-	-	-	-	-
726	EU 96/97	97.55	15	1	0.1	Deer	-	Due claw	-	Complete	-	1	-	-	-	-	-	-	-
726	EU 96/97	97.55	15	2	6.0	Deer	-	Metapodial	Immature	Distal	-	2	-	-	-	-	-	-	-

Appendix A, continued

Lot #	Unit	Elevation	Feature	Qty	Wt (g)	Taxon	Species	Element	Age	Portion	Side	Size, 0-3 cm	Size, 3-6 cm	Size, 6-9 cm	Size, 9-12 cm	Size, >12 cm	Burned (Color)	Cut Marks (Type)	Comments
726	EU 96/97	97.53	15	2	42.2	Deer		Tibia	Immature	Distal	R	1	-	-	-	1	-	-	unfused cap, dry break
726	EU 96/97	97.53	15	1	11.0	Deer	-	Astragalus	-	Complete	R	-	1	-	-	-	-	3 thin	-
726	EU 96/97	97.54	15	3	53.0	Deer	-	Metatarsal	Immature	Complete	R	5	-	-	-	1	-	-	no cuts
726	EU 96/97	97.54	15	1	6.5	Deer	-	Navicular cuboid	-	Complete	R	1	-	-	-	-	-	-	-
726	EU 96/97	97.54	15	1	1.0	Deer	-	Cuneiform pes	-	Complete	R	1	-	-	-	-	-	-	-
726	EU 96/97	97.54	15	7	39.6	Deer	-	Mandible	young	Medial	R	3	3	-	-	1	-	-	P4 in place M3 erupting
752	EU 156 (Feat. 16 flotation)	98.55-98.50	16	15	0.1	Indeterminate	-	-	-	Frags	-	15	-	-	-	-	-	-	-
753	EU 156 (Feat. 16 flotation)	98.50-98.41	16	17	0.1	Indeterminate	-	-	-	Frags	-	17	-	-	-	-	-	-	-
754	EU 156 (Feat. 16 flotation)	98.50-98.41	16	16	0.1	Indeterminate	-	-	-	Frags	-	16	-	-	-	-	-	-	-
755	EU 136 (Feat. 17 flotation)	97.66-97.60	17	31	1.7	Indeterminate	-	-	-	Frags	-	31	-	-	-	-	-	-	-
755	EU 136 (Feat. 17 flotation)	97.66-97.60	17	3	0.5	Fish	-	Skull	-	Frags	-	3	-	-	-	-	-	-	-
1	TU 1	99.12-99.02	-	1	0.1	Indeterminate	-	-	-	-	-	1	-	-	-	-	-	-	-
2	TU 1	99.02-98.92	-	1	0.1	Bird	-	Carpometacarpus	-	Complete	L	1	-	-	-	-	-	-	-
3	TU 1	98.92-98.82	-	1	0.1	Turtle	-	Carapace	-	-	-	1	-	-	-	-	-	-	-
4	TU 1	98.82-98.72	-	5	1.2	Fish	-	Skull	-	Frags	-	5	-	-	-	-	-	-	-
5	TU 1	98.72-98.62	-	1	0.1	Turtle	-	Carapace	-	Frags	-	1	-	-	-	-	-	-	edge
5	TU 1	98.72-98.62	-	1	0.2	Indeterminate	-	-	-	Frags	-	1	-	-	-	-	-	-	-
7	TU 1	98.52-98.42	-	1	0.1	Rabbit size	-	Long bone	-	Medial	-	1	-	-	-	-	-	-	-
8	TU 1	98.42-98.32	-	1	0.1	Indeterminate	-	-	-	Frags	-	1	-	-	-	-	-	-	-
9	TU 2	99.12-99.02	-	1	0.1	Indeterminate	-	-	-	Frags	-	1	-	-	-	-	-	-	-
11	TU 2	98.92-98.82	-	1	0.3	Turtle	-	Plastron	-	Frags	-	1	-	-	-	-	-	-	-
11	TU 2	98.92-98.82	-	1	0.1	Turtle	-	Carapace	-	Frags	-	1	-	-	-	-	-	-	-
11	TU 2	98.92-98.82	-	1	0.1	Indeterminate	-	-	-	Frags	-	1	-	-	-	-	-	-	-
12	TU 2	98.82-98.72	-	1	0.1	Indeterminate	-	-	-	Frags	-	1	-	-	-	-	-	-	-
13	TU 2	98.72-98.62	-	6	0.8	Rabbit	-	Mandible	-	Medial	-	6	-	-	-	-	-	-	-
13	TU 2	98.72-98.62	-	2	0.6	Indeterminate	-	-	-	Frags	-	2	-	-	-	-	-	-	-
14	TU 2	98.62-98.52	-	4	0.5	Indeterminate	-	-	-	Frags	-	4	-	-	-	-	-	-	-
17	TU 2	98.32-98.22	-	1	0.1	Indeterminate	-	-	-	Frags	-	1	-	-	-	-	-	-	-
19	TU 3	98.90-98.80	-	1	0.1	Indeterminate	-	Long bone	-	Medial	-	1	-	-	-	-	-	-	-
20	TU 3	98.90-98.80	-	1	1.3	Deer size	-	-	-	Frags	-	1	-	-	-	-	-	-	-
20	TU 3	98.90-98.80	-	1	0.1	Rodent	-	Mandible	-	Medial	R	1	-	-	-	-	-	-	-
20	TU 3	98.90-98.80	-	1	0.1	Indeterminate	-	Long bone	-	Frags	-	1	-	-	-	-	-	-	-
22	TU 3	98.50-98.40	-	1	0.3	Indeterminate	-	Long bone	-	Frags	-	1	-	-	-	-	-	-	-
26	TU 4	98.90-98.80	-	4	0.8	Indeterminate	-	Long bone	-	Frags	-	4	-	-	-	-	-	-	-
27	TU 4	98.80-98.70	-	1	0.1	Indeterminate	-	Long bone	-	Frags	-	1	-	-	-	-	-	-	-
27	TU 4	98.80-98.70	-	1	0.1	Indeterminate	-	Long bone	-	Frags	-	1	-	-	-	-	brown	-	-
28	TU 4	98.50-98.40	-	1	0.1	Indeterminate	-	Long bone	-	Frags	-	1	-	-	-	-	-	-	-

Appendix A, continued

Lot #	Unit	Elevation	Feature	Qty	Wt (g)	Taxon	Species	Element	Age	Portion	Side	Size, 0-3 cm	Size, 3-6 cm	Size, 6-9 cm	Size, 9-12 cm	Size, >12 cm	Burned (Color)	Cut Marks (Type)	Comments
31	TU 4	98.10-98.00	-	2	0.3	Indeterminate	-	-	-	Frags	-	2	-	-	-	-	-	-	-
33	TU 5	99.24-99.14	-	1	1.4	Deer size	-	Long bone	-	Frags	-	1	-	-	-	-	-	-	-
34	TU 5	99.14-99.04	-	2	6.9	Deer size	-	Metapodial	M	Distal	-	2	-	-	-	-	brown/black partial	-	-
35	TU 5	98.84-98.74	-	5	34.5	Deer size	-	Axis	-	Medial	-	3	2	-	-	-	-	-	rodent chewed
39	TU 5	99.44-99.34	-	1	0.2	Indeterminate	-	-	-	Frags	-	1	-	-	-	-	-	-	-
41	TU 6	99.24-99.14	-	1	0.2	Snake	-	Vertebra	-	Complete	-	1	-	-	-	-	-	-	-
41	TU 6	99.24-99.14	-	1	0.1	Rodent	-	Mandible	-	Complete	R	1	-	-	-	-	-	-	-
41	TU 6	99.24-99.14	-	2	1.7	Indeterminate	-	-	-	Frags	-	2	-	-	-	-	-	-	-
42	TU 6	99.14-99.04	-	8	4.2	Deer size	-	Long bone	-	Frags	-	8	-	-	-	-	-	-	-
44	TU 6	98.94-98.84	-	1	0.8	Deer size	-	Long bone	-	Frags	-	1	-	-	-	-	black and white	-	-
45	TU 6	98.84-98.74	-	1	0.1	Indeterminate	-	-	-	Frags	-	1	-	-	-	-	-	-	-
48	TU 6	98.54-98.44	-	2	1.2	Indeterminate	-	Long bone	-	Frags	-	2	-	-	-	-	-	-	-
50	TU 7	98.39-98.29	-	4	2.8	Indeterminate	-	Long bone	-	Medial	-	4	-	-	-	-	3 white, 1 black	-	-
50	TU 7	98.39-98.29	-	3	2.0	Indeterminate	-	Long bone	-	Medial	-	3	-	-	-	-	-	-	-
51	TU 7	98.29-98.19	-	1	0.3	Indeterminate	-	Long bone	-	Medial	-	1	-	-	-	-	-	-	-
51	TU 7	98.29-98.19	-	2	0.4	Rabbit size	-	Long bone	-	Medial	-	2	-	-	-	-	-	-	-
53	TU 7	98.99-97.99	-	1	0.2	Rabbit size	-	Skull	-	Medial	-	1	-	-	-	-	-	-	-
53	TU 7	98.99-97.99	-	1	0.1	Turtle	-	Carapace	-	Frags	-	1	-	-	-	-	-	-	edge
53	TU 7	98.99-97.99	-	1	0.2	Rodent	-	Long bone	-	Medial	-	1	-	-	-	-	-	-	-
56	TU 8	98.39-98.29	-	1	0.5	Indeterminate	-	Long bone	-	Medial	-	1	-	-	-	-	-	-	-
57	TU 8	98.29-98.19	-	7	4.0	Deer size	-	Long bone	-	Medial	-	7	-	-	-	-	3 white, 4 brown/ black	-	-
57	TU 8	98.29-98.19	-	9	6.6	Deer size	-	Long bone	-	Medial	-	9	-	-	-	-	-	-	-
57	TU 8	98.29-98.19	-	1	0.3	Deer size	-	caudal vertebra	-	Medial	-	1	-	-	-	-	-	-	-
57	TU 8	98.29-98.19	-	3	0.6	Bird	-	Long bone	-	Medial	-	3	-	-	-	-	-	-	-
57-1	TU 8	98.29-98.19	-	1	0.7	Indeterminate	-	Long bone	-	Tip?	-	1	-	-	-	-	-	-	tool, spatula, use striations
58	TU 8	98.19-98.09	-	10	1.2	Fish	-	Skull	-	Frags	-	10	-	-	-	-	-	-	-
58	TU 8	98.19-98.09	-	1	0.5	Indeterminate	-	Long bone	-	Frags	-	1	-	-	-	-	-	-	-
59	TU 8	98.09-97.99	-	2	8.3	Deer size	-	Long bone	-	Frags	-	-	2	-	-	-	-	-	-
59	TU 8	98.09-97.99	-	2	0.1	Bird	-	Long bone	-	Medial	-	2	-	-	-	-	-	-	-
59	TU 8	98.09-97.99	-	7	2.1	Indeterminate	-	-	-	Frags	-	7	-	-	-	-	-	-	-
60	TU 8	97.99-97.89	-	4	4.9	Deer size	-	Long bone	-	Medial	-	4	-	-	-	-	-	-	-
61	TU 8	97.89-97.79	-	1	0.5	Deer size	-	Long bone	-	Medial	-	1	-	-	-	-	-	-	-
62	TU 8	97.79-97.69	-	1	0.3	Indeterminate	-	Long bone	-	Frags	-	2	-	-	-	-	-	-	-
63	TU 8	97.69-97.59	-	1	1.7	Deer size	-	Scaphoid	-	Complete	L	1	-	-	-	-	-	-	-
63	TU 8	97.69-97.59	-	1	0.6	Deer size	-	Phalange	-	Lateral	-	1	-	-	-	-	-	-	-
63	TU 8	97.69-97.59	-	1	0.4	Rabbit size	-	Skull	-	Frags	-	1	-	-	-	-	-	-	-
63	TU 8	97.69-97.59	-	3	1.1	Indeterminate	-	-	-	Frags	-	3	-	-	-	-	-	-	-
64	TU 8	97.59-97.49	-	1	0.3	Indeterminate	-	-	-	Frags	-	1	-	-	-	-	-	-	-
64	TU 8	97.59-97.49	-	1	0.5	Deer size	-	Phalange	-	Lateral	-	1	-	-	-	-	-	-	-
65	TU 9	99.12-99.02	-	1	0.4	Indeterminate	-	Long bone	-	Medial	-	1	-	-	-	-	-	-	-
67	TU 9	98.92-98.82	-	1	0.1	Rodent	-	Humerus	-	Distal	L	1	-	-	-	-	-	-	-
67	TU 9	98.92-98.82	-	1	0.1	Indeterminate	-	-	-	Frags	-	1	-	-	-	-	-	-	-

Appendix A, continued

Lot #	Unit	Elevation	Feature	Qty	Wt (g)	Taxon	Species	Element	Age	Portion	Side	Size, 0-3 cm	Size, 3-6 cm	Size, 6-9 cm	Size, 9-12 cm	Size, >12 cm	Burned (Color)	Cut Marks (Type)	Comments
69	TU 10	98.49-98.39	-	1	0.2	Turtle	-	Carapace	-	Frags	-	1	-	-	-	-	-	-	edge
69	TU 10	98.49-98.39	-	2	0.1	Fish	-	Skull	-	Frags	-	2	-	-	-	-	-	-	-
70	TU 10	98.39-98.29	-	5	1.1	Turtle	-	Plastron	-	Frags	-	5	-	-	-	-	-	-	-
70	TU 10	98.39-98.29	-	1	0.5	Deer size	-	-	-	Frags	-	1	-	-	-	-	-	multiple small	-
70	TU 10	98.39-98.29	-	1	1.0	Deer size	-	Long bone	-	Medial	-	1	-	-	-	-	-	-	-
71	TU 10	98.29-98.19	-	3	1.2	Indeterminate	-	-	-	Frags	-	3	-	-	-	-	-	-	-
73	TU 10	97.99-97.89	-	3	4.6	Deer size	-	Long bone	-	Medial	-	2	1	-	-	-	-	-	-
73	TU 10	97.99-97.89	-	1	0.3	Rabbit size	-	Skull	-	Medial	-	1	-	-	-	-	-	-	waterworn-rounded
73	TU 10	97.99-97.89	-	5	1.2	Bird	-	Long bone	-	Medial	-	5	-	-	-	-	-	-	1 dark stained
74	TU 10	97.89-97.79	-	1	0.1	Indeterminate	-	Rib cartilage	-	Medial	-	1	-	-	-	-	-	tooth punture	-
74	TU 10	97.89-97.79	-	2	1.1	Indeterminate	-	Long bone	-	Medial	-	2	-	-	-	-	-	-	-
77	TU 10	97.59-97.49	-	1	7.5	Deer size	-	Long bone	-	Medial	-	-	-	1	-	-	-	-	spiral fractured
77	TU 10	97.59-97.49	-	1	0.9	Deer size	-	Long bone	-	Medial	-	1	-	-	-	-	brown/gray	-	impact scar
80	TU 10	98.29-98.19	-	1	0.6	Deer size	-	Phalange	-	Distal	-	1	-	-	-	-	white/gray	-	-
80	TU 10	98.29-98.19	-	8	1.1	Bird size	-	Long bone	-	Medial	-	8	-	-	-	-	-	-	weathered
80	TU 10	98.29-98.19	-	11	15.3	Deer size	-	Long bone	-	Medial	-	10	1	-	-	-	-	-	-
80	TU 10	98.29-98.19	-	5	0.8	Indeterminate	-	-	-	Frags	-	5	-	-	-	-	1 white	-	-
82	TU 12	98.30-98.20	-	5	1.7	Deer size	-	Rib	-	Medial	-	5	-	-	-	-	5 black	-	-
82	TU 12	98.30-98.20	-	7	11.1	Deer size	-	Vertebra	-	Medial	-	6	1	-	-	-	-	-	-
82	TU 12	98.30-98.20	-	2	2.8	Deer size	-	Rib	-	Frags	-	2	-	-	-	-	-	-	-
82	TU 12	98.30-98.20	-	15	11.6	Deer size	-	Long bone	-	Medial	-	15	-	-	-	-	-	-	-
83	TU 12	98.10-98.00	-	4	1.1	Indeterminate	-	Long bone	-	Medial	-	4	-	-	-	-	-	-	-
85	TU 12	97.90-97.80	-	1	0.1	Indeterminate	-	Long bone	-	Medial	-	1	-	-	-	-	-	-	-
88	TU 13	98.10-98.00	-	1	0.3	Bird	-	Long bone	-	Distal	-	1	-	-	-	-	-	-	-
89	TU 13	98.00-97.90	-	1	1.1	Indeterminate	-	Long bone	-	Medial	-	1	-	-	-	-	-	-	-
89	TU 13	98.00-97.90	-	1	0.6	Bird	-	Long bone	-	Medial	-	1	-	-	-	-	-	-	-
90	TU 13	97.90-97.80	-	1	0.3	Indeterminate	-	Long bone	-	Medial	-	1	-	-	-	-	-	-	dark stained
91	TU 13	97.80-97.70	-	1	1.8	Deer size	-	Long bone	-	Medial	-	1	-	-	-	-	-	-	dark stained
92	TU 13	97.70-97.60	-	1	1.7	Deer size	-	Long bone	-	Medial	-	1	-	-	-	-	-	-	rodent chewed
93	TU 13	97.60-97.50	-	1	0.2	Indeterminate	-	-	-	Frags	-	1	-	-	-	-	-	-	-
94	TU 13	97.50-97.40	-	8	6.8	Bird	Turkey size	Long bone	-	Medial	-	6	2	-	-	-	-	15+ thin	-
96	TU 14	98.03-97.93	-	1	0.1	Fish	-	-	-	Frags	-	1	-	-	-	-	-	-	-
96	TU 14	98.03-97.93	-	15	35.0	Bison size	-	Rib	-	Medial	-	10	1	3	1	-	-	-	-
97	TU 14	97.93-97.83	-	8	7.8	Deer size	-	Rib	-	Medial	-	6	2	-	-	-	-	-	rodent chewed
98	TU 14	97.83-97.73	-	4	0.9	Indeterminate	-	-	-	Frags	-	4	-	-	-	-	-	-	-
99	TU 14	97.73-97.63	-	8	34.9	Bison size	-	Rib	-	Frags	-	4	2	2	-	-	-	multiple thin cuts	-
100	TU 14	97.63-97.53	-	1	0.2	Turtle	-	Carapace	-	Frags	-	1	-	-	-	-	-	-	-
101	TU 15	98.03-97.93	-	5	13.9	Deer size	-	Lumbar vertebra	-	Frags	-	3	2	-	-	-	-	-	-
102	TU 15	97.93-97.83	-	1	1.9	Deer	-	3rd Phalange	-	Complete	-	1	-	-	-	-	-	-	-
102	TU 15	97.93-97.83	-	1	6.2	Bison size	-	-	-	Frags	-	-	1	-	-	-	-	-	-
102	TU 15	97.93-97.83	-	1	8.8	Deer size	-	Long bone	-	Medial	-	-	-	1	-	-	-	-	-
102	TU 15	97.93-97.83	-	1	1.3	Deer size	-	Rib	-	Medial	-	-	1	-	-	-	-	-	-
102	TU 15	97.93-97.83	-	8	5.3	Indeterminate	-	-	-	Frags	-	8	-	-	-	-	2 black	-	-
103	TU 15	97.83-97.73	-	5	2.6	Indeterminate	-	-	-	Frags	-	5	-	-	-	-	1 black	-	-
105	TU 15	97.63-97.53	-	1	1.6	Turtle	-	Carapace	-	Frags	-	-	1	-	-	-	-	-	dark stained

Appendix A, continued

Lot #	Unit	Elevation	Feature	Qty	Wt (g)	Taxon	Species	Element	Age	Portion	Side	Size, 0-3 cm	Size, 3-6 cm	Size, 6-9 cm	Size, 9-12 cm	Size, >12 cm	Burned (Color)	Cut Marks (Type)	Comments
110	TU 15	97.13-97.03	-	1	0.1	Turtle	-	Carapace	-	Frags	-	1	-	-	-	-	-	-	-
110	TU 15	97.13-97.03	-	4	0.6	Indeterminate	-	-	-	Frags	-	4	-	-	-	-	1 brown	-	-
112	TU 16	97.93-97.83	-	1	2.9	Deer size	-	Rib	-	Medial	-	-	1	-	-	-	-	-	spots dark stained
113	TU 16	97.93-97.83	-	5	2.7	Deer size	-	Rib	-	Medial	-	5	-	-	-	-	black/brown	-	-
113	TU 16	97.93-97.83	-	54	179.7	Bison	-	Scapula	-	proximal	L	49	3	-	2	-	-	-	spots dark stained
115	TU 16	97.63-97.53	-	2	5.9	Deer size	-	Skull, ear	-	Medial	-	2	-	-	-	-	-	-	-
116	TU 17	98.03-97.93	-	1	0.7	Indeterminate	-	-	-	Frags	-	1	-	-	-	-	-	-	-
117	TU 17	97.93-97.83	-	3	4.0	Deer size	-	Rib	-	Medial	-	3	-	-	-	-	-	1 thin cut	dark stained
117	TU 17	97.93-97.83	-	2	4.1	Bison size	-	Cancellous	-	Frags	-	2	-	-	-	-	-	-	-
117	TU 17	97.93-97.83	-	7	2.3	Indeterminate	-	-	-	Frags	-	7	-	-	-	-	-	-	-
118	TU 17	97.83-97.73	-	1	5.2	Dog size	-	Metapodial	-	Complete	-	-	-	1	-	-	-	1 thick	dark stained
118	TU 17	97.83-97.73	-	1	1.2	Deer size	-	3rd Phalange	-	Nearly Complete	-	1	-	-	-	-	-	-	dark stained
118	TU 17	97.83-97.73	-	2	5.1	Bison size	-	Rib	-	Medial	-	1	-	1	-	-	-	-	-
118	TU 17	97.83-97.73	-	3	7.1	Deer size	-	Rib	-	Medial	-	2	-	1	-	-	-	-	-
118	TU 17	97.83-97.73	-	4	2.4	Deer size	-	Rib	-	Medial	-	4	-	-	-	-	4 black	-	-
118	TU 17	97.83-97.73	-	11	5.2	Indeterminate	-	-	-	Frags	-	11	-	-	-	-	-	-	-
120	TU 17	97.63-97.53	-	4	10.1	Bison	-	Sesimoid	-	Complete	-	4	-	-	-	-	-	-	-
121	TU 18	98.03-97.93	-	3	3.6	Bison size	-	Rib	-	Medial	-	3	-	-	-	-	-	-	-
121	TU 18	98.03-97.93	-	2	7.9	Deer size	-	Rib	-	Medial	-	-	1	1	-	-	-	-	-
121	TU 18	98.03-97.93	-	4	2.0	Indeterminate	-	-	-	Frags	-	4	-	-	-	-	-	-	-
122	TU 18	97.93-97.83	-	21	12.7	Indeterminate	-	-	-	Frags	-	21	-	-	-	-	1 black	-	6 dark stained
128	TU 19	98.03-97.93	-	1	0.2	Indeterminate	-	-	-	Frags	-	1	-	-	-	-	white	-	-
129	TU 19	97.93-97.83	-	1	1.8	Deer size	-	Rib	-	Medial	-	1	-	-	-	-	brown	-	-
129	TU 19	97.93-97.83	-	8	2.4	Indeterminate	-	-	-	Frags	-	7	1	-	-	-	-	-	-
130	TU 19	97.83-97.73	-	1	0.1	Rabbit size	-	Vertebra	-	Complete	-	1	-	-	-	-	-	-	-
130	TU 19	97.83-97.73	-	1	0.1	Indeterminate	-	-	-	Frags	-	1	-	-	-	-	-	-	-
130	TU 19	97.83-97.73	-	13	13.4	Deer size	-	Rib	-	Medial	-	5	7	1	-	-	-	-	-
131	TU 19	97.73-97.63	-	1	1.0	Deer	-	3rd Phalange	-	Lateral	-	1	-	-	-	-	-	-	-
131	TU 19	97.73-97.63	-	1	0.2	Turtle	-	Carapace	-	Frags	-	1	-	-	-	-	-	-	-
131	TU 19	97.73-97.63	-	9	14.2	Bison size	-	Rib	-	Medial	-	7	-	-	2	-	-	-	-
132	TU 19	97.63-97.53	-	1	8.4	Deer size	-	Tibia	-	Distal	L	-	1	-	-	-	-	2 thin cuts	rodent chewed
132	TU 19	97.63-97.53	-	1	0.3	Turtle	-	Carapace	-	Frags	-	1	-	-	-	-	-	-	-
132	TU 19	97.63-97.53	-	1	0.5	Rodent	-	Maxillary	-	Proximal	-	1	-	-	-	-	-	-	-
132	TU 19	97.63-97.53	-	3	4.6	Indeterminate	-	-	-	Frags	-	2	1	-	-	-	-	-	-
141	TU 3	98.10-98.00	-	2	0.2	Indeterminate	-	-	-	Frags	-	2	-	-	-	-	-	-	-
147	EU 1	98.70-98.60	-	6	3.4	Deer size	-	Long bone	-	Medial	-	5	1	-	-	-	-	-	eroded surface, spiral fracture
149	EU 2	98.60-98.50	-	1	7.8	Bison size	-	Long bone	-	Medial	-	-	1	-	-	-	-	-	-
150	EU 2	98.50-98.40	-	1	0.1	Indeterminate	-	-	-	Frags	-	1	-	-	-	-	-	-	-
152	EU 3	98.60-98.50	-	1	0.1	Bird size	-	Long bone	-	Medial	-	1	-	-	-	-	-	-	-
156	EU 4	98.60-98.50	-	1	1.8	Deer size	-	Long bone	-	Medial	-	-	1	-	-	-	-	5 thin cuts	-
156	EU 4	98.60-98.50	-	1	0.2	Rabbit size	-	Long bone	-	Medial	-	1	-	-	-	-	-	-	-
159	EU 5	98.60-98.50	-	2	5.1	Bison	-	Malleolus lateral	-	Medial	L	1	-	-	-	-	-	-	-

Appendix A, continued

Lot #	Unit	Elevation	Feature	Qty	Wt (g)	Taxon	Species	Element	Age	Portion	Side	Size, 0-3 cm	Size, 3-6 cm	Size, 6-9 cm	Size, 9-12 cm	Size, >12 cm	Burned (Color)	Cut Marks (Type)	Comments
159	EU 5	98.60-98.50	-	7	6.7	Deer size	-	Rib	-	Medial	-	5	1	1	-	-	-	-	-
159	EU 5	98.60-98.50	-	1	2.7	Deer size	-	Long bone	-	Medial	-	-	1	-	-	-	-	-	-
160	EU 5	98.50-98.40	-	2	1.1	Indeterminate	-	-	-	-	-	2	-	-	-	-	-	-	-
162	EU 6	98.50-98.40	-	1	27.1	Bison size	-	Long bone	-	Medial	-	-	-	-	1	-	-	-	weathered surface, rodent chewed
162	EU 6	98.50-98.40	-	1	0.6	Deer size	-	Rib	-	Medial	-	1	-	-	-	-	-	-	-
162	EU 6	98.50-98.40	-	7	2.5	Indeterminate	-	-	-	Frags	-	7	-	-	-	-	-	-	-
162	EU 6	98.50-98.40	-	1	2.4	Rabbit size	-	Long bone	-	Medial	-	1	-	-	-	-	-	-	-
162	EU 6	98.50-98.40	-	1	50.7	Bison size	-	Atlas	-	Lateral	-	-	-	1	-	-	-	2 deep cuts	-
162	EU 6	98.50-98.40	-	7	17.7	Bison size	-	Long bone	-	Medial	-	3	3	-	1	-	black/brown	-	-
165	EU 7	98.50-98.40	-	1	1.9	Turtle	-	Carapace	-	Lateral	-	1	-	-	-	-	-	-	weathered surface, rodent chewed
165	EU 7	98.50-98.40	-	2	2.5	Bison size	-	vertebra spine	-	Medial	-	2	-	-	-	-	-	-	rodent chewed
165	EU 7	98.50-98.40	-	1	0.6	Deer size	-	Long bone	-	Medial	-	1	-	-	-	-	black	-	-
165	EU 7	98.50-98.40	-	4	0.3	Indeterminate	-	-	-	Frags	-	4	-	-	-	-	2 brown	-	-
166	EU 7	98.40-98.30	-	1	1.0	Indeterminate	-	Long bone	-	Medial	-	1	-	-	-	-	-	-	-
166-1	EU 7	98.40-98.30	-	1	1.1	Indeterminate	-	-	-	Medial	-	1	-	-	-	-	-	-	tool, medial awl
167	EU 7	98.30-98.20	-	1	1.2	Deer size	-	Cuneiform pes	-	Medial	-	1	-	-	-	-	-	-	-
167	EU 7	98.30-98.20	-	3	0.6	Indeterminate	-	-	-	Frags	-	3	-	-	-	-	-	-	-
168	EU 8	98.55-98.40	-	3	4.3	Deer size	-	Long bone	-	Medial	-	3	-	-	-	-	-	-	-
169	EU 8	98.40-98.30	-	12	22.3	Bison size	-	Rib	-	Medial	-	8	2	2	-	-	-	1 bone with 4 cut thin	-
169	EU 8	98.40-98.30	-	1	1.5	Deer size	-	Long bone	-	Medial	-	-	1	-	-	-	-	-	-
169	EU 8	98.40-98.30	-	1	5.3	Deer size	-	Long bone	-	Medial	-	-	1	-	-	-	-	-	-
170	EU 8	98.30-98.20	-	3	2.3	Deer size	-	Long bone	-	Distal	-	3	-	-	-	-	3 black	-	-
170	EU 8	98.30-98.20	-	41	52.5	Bison size	-	Rib	-	Medial	-	27	7	6	1	-	-	-	1 rodent chewed
170	EU 8	98.30-98.20	-	1	5.1	Indeterminate	-	Long bone	-	Medial	-	-	1	-	-	-	-	-	-
170	EU 8	98.30-98.20	-	1	2.1	Deer size	-	Long bone	-	Medial	-	-	1	-	-	-	-	-	-
173	EU 9	98.40-98.30	-	1	3.1	Indeterminate	-	-	-	Frags	-	1	-	-	-	-	-	-	-
174	EU 9	98.30-98.20	-	1	2.3	Deer size	-	Long bone	-	Medial	-	-	1	-	-	-	-	-	-
174	EU 9	98.30-98.20	-	7	3.8	Deer size	-	Rib	-	Medial	-	7	-	-	-	-	-	-	-
174	EU 9	98.30-98.20	-	1	3.2	Deer size	-	Long bone	-	Distal	-	1	-	-	-	-	-	-	-
175	EU 9	98.20-98.10	-	1	5.7	Deer size	-	Long bone	-	Medial	-	-	1	-	-	-	-	-	spiral fractured
175	EU 9	98.20-98.10	-	1	0.8	Deer size	-	Rib	-	Medial	-	-	1	-	-	-	-	-	-
175	EU 9	98.20-98.10	-	1	0.2	Rabbit size	-	Long bone	-	Medial	-	1	-	-	-	-	-	-	-
175	EU 9	98.20-98.10	-	5	9.6	Rabbit size	-	Femur	-	Distal	R	4	1	-	-	-	-	-	-
176	EU 9	98.10-98.00	-	1	9.4	Deer size	-	Tibia	-	Medial	-	-	-	1	-	-	-	-	impact fracture
176	EU 9	98.10-98.00	-	1	1.1	Deer size	-	Long bone	-	Medial	-	-	1	-	-	-	-	-	-
176	EU 9	98.10-98.00	-	2	1.2	Indeterminate	-	Cancellous	-	Medial	-	2	-	-	-	-	-	-	-
177	EU 10	98.33-98.20	-	2	2.5	Deer size	-	Long bone	-	Medial	-	2	-	-	-	-	-	-	-
178	EU 10	98.20-98.10	-	1	0.1	Deer size	-	Rib	-	Medial	-	1	-	-	-	-	-	-	-
179	EU 10	98.10-98.00	-	1	0.2	Deer size	-	Rib	-	Medial	-	1	-	-	-	-	black	-	-
179	EU 10	98.10-98.00	-	9	3.8	Deer size	-	Long bone	-	Medial	-	8	1	-	-	-	-	3 thin cuts on 1 bone	-

Appendix A, continued

Lot #	Unit	Elevation	Feature	Qty	Wt (g)	Taxon	Species	Element	Age	Portion	Side	Size, 0-3 cm	Size, 3-6 cm	Size, 6-9 cm	Size, 9-12 cm	Size, >12 cm	Burned (Color)	Cut Marks (Type)	Comments
180	EU 10	98.00-97.90	-	1	0.6	Deer size	-	Sesimoid	-	Complete	-	1	-	-	-	-	-	-	-
180	EU 10	98.00-97.90	-	1	0.1	Indeterminate	-	Long bone	-	Distal	-	1	-	-	-	-	-	-	-
181	EU 11	98.21-98.10	-	2	0.7	Deer size	-	Rib	-	Medial	-	2	-	-	-	-	-	-	-
182	EU 11	98.10-98.00	-	1	125.1	Bison	-	Calcanium	Mature	Complete	R	-	-	-	-	1	-	-	Rodent chewed, massive
182	EU 11	98.10-98.00	-	13	6.6	Indeterminate	-	-	-	Frags	-	12	1	-	-	-	-	-	-
182	EU 11	98.10-98.00	-	1	0.3	Rabbit size	-	Long bone	-	Medial	-	1	-	-	-	-	-	-	rodent chewed, spiral fractured
183	EU 11	98.00-97.90	-	1	8.3	Bison	-	Cuneiform pes	-	Complete	L	-	1	-	-	-	-	-	-
183	EU 11	98.00-97.90	-	5	4.9	Turtle	-	Carapace	-	Frags	-	-	1	-	-	-	-		edge, patches of dark stains
183	EU 11	98.00-97.90	-	3	8.0	Deer size	-	Long bone	-	Medial	-	2	1	-	-	-	-	1 long thin	-
183	EU 11	98.00-97.90	-	4	3.7	Deer size	-	Rib	-	Medial	-	4	-	-	-	-	-	-	-
183	EU 11	98.00-97.90	-	10	2.5	Indeterminate	-	-	-	Frags	-	10	-	-	-	-	-	-	-
185	EU 12	98.70-98.60	-	2	1.0	Deer size	-	Rib	-	Medial	-	2	-	-	-	-	-	-	-
187	EU 13	98.70-98.60	-	3	6.4	Deer size	-	Long bone	-	Medial	-	2	-	1	-	-	-	-	spiral fractured
188	EU 13	98.60-98.50	-	1	0.5	Deer size	-	Phalange	-	Distal	-	1	-	-	-	-	-	-	fractured
189	EU 14	98.80-98.70	-	1	0.1	Indeterminate	-	-	-	Frags	-	1	-	-	-	-	black	-	-
189	EU 14	98.80-98.70	-	1	0.4	Indeterminate	-	-	-	Frags	-	2	-	-	-	-	-	-	-
190	EU 14	98.70-98.60	-	3	0.7	Indeterminate	-	-	-	Frags	-	3	-	-	-	-	-	-	-
193	EU 15	98.70-98.60	-	2	1.8	Deer size	-	Metapodial	-	Medial	-	-	-	2	-	-	-	-	spiral fractured
193	EU 15	98.70-98.60	-	3	2.3	Deer size	-	Long bone	-	Medial	-	3	-	-	-	-	-	-	-
193	EU 15	98.70-98.60	-	2	0.4	Indeterminate	-	-	-	Frags	-	2	-	-	-	-	-	-	-
195	EU 16	99.70-99.60	-	2	1.4	Deer size	-	Rib	-	Medial	-	2	-	-	-	-	-	-	-
195-4	EU 16	99.70-99.60	-	1	0.2	Indeterminate	-	-	-	Frags	-	1	-	-	-	-	-	-	not modified
196	EU 16	98.60-98.50	-	3	0.7	Indeterminate	-	-	-	Frags	-	3	-	-	-	-	-	-	-
197	EU 16	98.50-98.40	-	4	1.0	Indeterminate	-	-	-	Frags	-	4	-	-	-	-	-	-	-
198	EU 17	98.60-98.50	-	3	306.5	Bison	-	Metacarpal	old	Complete	L	-	-	-	-	1	-	-	dry bone break, weathered surface
199	EU 17	98.50-98.40	-	1	0.6	Deer size	-	Rib	-	Medial	-	-	1	-	-	-	-	-	-
199	EU 17	98.50-98.40	-	2	0.4	Indeterminate	-	-	-	Frags	-	2	-	-	-	-	-	-	-
200	EU 17	98.40-98.30	-	1	0.1	Rabbit	Jack	Femur cap	-	Distal	R	1	-	-	-	-	-	-	-
202	EU 18	98.50-98.40	-	1	37.7	Bison	-	Spine	-	Medial	-	-	-	-	-	1	-	-	rodent chewed
202	EU 18	98.50-98.40	-	3	3.2	Indeterminate	-	-	-	Frags	-	2	1	-	-	-	-	-	-
203	EU 18	98.40-98.30	-	1	0.2	Rabbit size	-	Long bone	-	Medial	-	1	-	-	-	-	-	-	-
203	EU 18	98.40-98.30	-	1	0.9	Indeterminate	-	Vertebra	-	Lateral	-	1	-	-	-	-	-	-	-
203	EU 18	98.40-98.30	-	7	3.7	Indeterminate	-	-	-	Frags	-	5	2	-	-	-	-	-	-
204	EU 18	98.30-98.20	-	1	0.5	Indeterminate	-	Long bone	-	Medial	-	1	-	-	-	-	-	-	-
205	EU 19	98.55-98.30	-	1	3.8	Deer size	-	Long bone	-	Medial	-	-	-	1	-	-	-	-	rodent chewed
206	EU 19	98.40-98.30	-	2	3.4	Deer size	-	Long bone	-	Frags	-	2	-	-	-	-	-	-	-
206	EU 19	98.40-98.30	-	1	0.1	Indeterminate	-	-	-	Frags	-	1	-	-	-	-	-	-	-
207	EU 19	98.30-98.20	-	1	0.6	Indeterminate	-	-	-	Frags	-	-	1	-	-	-	-	-	-
208	EU 8	98.20-98.10	-	1	0.9	Indeterminate	-	-	-	medial		-	1	-	-	-	-	-	awl like

Appendix A, continued

Lot #	Unit	Elevation	Feature	Qty	Wt (g)	Taxon	Species	Element	Age	Portion	Side	Size, 0-3 cm	Size, 3-6 cm	Size, 6-9 cm	Size, 9-12 cm	Size, >12 cm	Burned (Color)	Cut Marks (Type)	Comments
209	EU 20	98.53-98.40	-	1	2.6	Deer size	-	Long bone	-	Medial	-	-	1	-	-	-	-	-	spiral fractured
210	EU 20	98.40-98.30	-	1	4.6	Deer size	-	-	-	Medial	-	-	-	1	-	-	-	-	tool, medial awl
210	EU 20	98.40-98.30	-	3	0.9	Indeterminate	-	-	-	Frags	-	3	-	-	-	-	-	-	-
211	EU 20	98.30-98.20	-	3	6.2	Deer size	-	Long bone	-	Medial	-	2	1	-	-	-	-	-	-
211	EU 20	98.30-98.20	-	1	1.0	Rabbit size	-	Long bone	-	Medial	-	-	1	-	-	-	-	-	rodent chewed
212	EU 20	98.20-98.10	-	4	3.4	Deer size	-	Rib	-	Medial	-	4	-	-	-	-	-	-	-
212	EU 20	98.20-98.10	-	1	5.0	Deer size	-	Long bone	-	Medial	-	-	-	1	-	-	-	multiple thin cuts	long impact fracture
214	EU 21	98.42-98.30	-	1	0.3	Deer size	-	Long bone	-	Medial	-	1	-	-	-	-	-	-	-
216	EU 21	98.20-98.10	-	1	2.2	Deer size	-	Long bone	-	Medial	-	1	-	-	-	-	-	-	spiral fractured
216	EU 21	98.20-98.10	-	1	0.3	Deer size	-	Rib	-	Medial	-	1	-	-	-	-	-	-	-
217	EU 21	98.10-98.00	-	2	3.7	Deer size	-	Long bone	-	Medial	-	-	2	-	-	-	-	-	-
217	EU 21	98.10-98.00	-	5	9.0	Deer size	-	Maxillary	very old	Medial	L	4	1	-	-	-	-	-	worn, fragmented
217	EU 21	98.10-98.00	-	11	2.5	Indeterminate	-	-	-	Frags	-	11	-	-	-	-	1 black	-	-
220	EU 22	98.20-98.10	-	4	4.0	Deer size	-	Rib	-	Medial	-	2	2	-	-	-	-	-	-
220	EU 22	98.20-98.10	-	2	4.3	Deer size	-	Long bone	-	Medial	-	1	1	-	-	-	-	-	-
221	EU 22	98.10-98.00	-	4	18.3	Deer size	-	Long bone	-	Medial	-	-	3	1	-	-	-	-	-
221	EU 22	98.10-98.00	-	1	0.2	Indeterminate	-	-	-	Frags	-	1	-	-	-	-	1 white	-	-
221	EU 22	98.10-98.00	-	1	1.6	Bison size	-	Sesimoid	-	Complete	-	1	-	-	-	-	-	-	-
221	EU 22	98.10-98.00	-	12	4.8	Indeterminate	-	-	-	Frags	-	12	-	-	-	-	-	-	-
222	EU 22	98.80-97.90	-	1	0.1	Indeterminate	-	-	-	Frags	-	1	-	-	-	-	-	-	-
223	EU 23	98.80-98.70	-	6	4.8	Deer size	-	Long bone	-	Medial	-	5	1	-	-	-	-	-	-
224	EU 23	98.70-98.60	-	2	0.7	Deer size	-	Phalange	-	Distal	-	2	-	-	-	-	-	-	-
224	EU 23	98.70-98.60	-	1	6.4	Bison	-	Femur	fetal	Medial	R	-	1	-	-	-	-	-	medial, nearly new born
224	EU 23	98.70-98.60	-	6	0.3	Indeterminate	-	-	-	Frags	-	6	-	-	-	-	-	-	-
225	EU 23	98.60-98.50	-	1	0.1	Indeterminate	-	-	-	Frags	-	1	-	-	-	-	-	-	-
226	EU 24	98.80-98.70	-	1	4.1	Bison	-	Rib	-	Medial	-	-	-	1	-	-	-	-	-
226	EU 24	98.80-98.70	-	3	13.3	Bison size	-	-	-	Frags	-	4	1	-	-	-	-	-	-
226	EU 24	98.80-98.70	-	5	11.3	Deer size	-	Long bone	-	Medial	-	-	5	-	-	-	-	-	-
226	EU 24	98.80-98.70	-	11	3.3	Indeterminate	-	-	-	Frags	-	11	-	-	-	-	-	-	-
227	EU 24	98.70-98.60	-	1	10.3	Bison size	-	Rib	-	Medial	-	-	-	1	-	-	-	-	rodent chewed
227	EU 24	98.70-98.60	-	1	2.0	Deer size	-	Long bone	-	Medial	-	1	-	-	-	-	-	-	-
227	EU 24	98.70-98.60	-	11	3.9	Indeterminate	-	Long bone	-	Medial	-	9	2	-	-	-	-	-	-
227	EU 24	98.70-98.60	-	1	0.1	Rodent size	-	Vertebra	-	Complete	-	1	-	-	-	-	-	-	-
228	EU 25	98.35-98.30	-	1	0.6	Indeterminate	-	Long bone	-	Medial	-	1	-	-	-	-	-	-	-
229	EU 25	98.30-98.20	-	2	0.5	Indeterminate	-	Rib	-	Medial	-	2	-	-	-	-	-	-	-
230	EU 25	98.20-98.10	-	3	0.9	Indeterminate	-	-	-	Frags	-	3	-	-	-	-	-	-	-
230	EU 25	98.20-98.10	-	1	5.8	Deer size	-	Long bone	-	Medial	-	-	-	1	-	-	-	-	-
230	EU 25	98.20-98.10	-	2	1.1	Deer size	-	Rib	-	Medial	-	2	-	-	-	-	-	-	-
232	EU 25	98.00-97.90	-	1	0.2	Indeterminate	-	-	-	Frags	-	1	-	-	-	-	-	-	-
234	EU 26	98.30-98.20	-	1	1.2	Deer size	-	Tooth	-	Complete	-	1	-	-	-	-	-	-	-
234	EU 26	98.30-98.20	-	2	2.5	Deer size	-	Long bone	-	Medial	-	2	-	-	-	-	-	-	-
235	EU 26	98.20-98.10	-	1	1.5	Indeterminate	-	Long bone	-	Medial	-	1	-	-	-	-	-	-	all edges rounded

Appendix A, continued

Lot #	Unit	Elevation	Feature	Qty	Wt (g)	Taxon	Species	Element	Age	Portion	Side	Size, 0-3 cm	Size, 3-6 cm	Size, 6-9 cm	Size, 9-12 cm	Size, >12 cm	Burned (Color)	Cut Marks (Type)	Comments
237	EU 27	98.30-98.20	-	1	1.0	Deer size	-	Long bone	-	Medial	-	1	-	-	-	-	-	-	bone flake
238	EU 27	98.20-98.10	-	8	9.3	Deer size	-	Rib	-	Medial	-	-	1	-	-	-	-	-	-
238	EU 27	98.20-98.10	-	2	9.8	Deer size	-	Long bone	-	Medial	-	-	2	-	-	-	-	-	-
241	EU 28	98.44-98.30	-	1	0.2	Indeterminate	-	-	-	Frags	-	1	-	-	-	-	-	-	-
242	EU 28	98.30-98.20	-	2	3.4	Indeterminate	-	-	-	Frags	-	2	-	-	-	-	dark brown	-	spiral fractured
242	EU 28	98.30-98.20	-	2	9.3	Bison	-	Rib	-	Medial	-	-	2	-	-	-	-	-	-
242	EU 28	98.30-98.20	-	28	12.9	Indeterminate	-	Rib	-	Medial	-	27	1	-	-	-	-	-	-
244	EU 28	98.10-98.00	-	1	6.0	Deer size	-	Long bone	-	Medial	-	-	-	1	-	-	-	-	-
244	EU 28	98.10-98.00	-	4	3.0	Indeterminate	-	Long bone	-	Medial	-	4	-	-	-	-	-	-	-
244	EU 28	98.10-98.00	-	1	0.3	Canid	-	2nd phalange	-	Complete	-	1	-	-	-	-	-	-	-
245	EU 29	98.18-98.10	-	1	0.1	Indeterminate	-	-	-	Frags	-	1	-	-	-	-	-	-	-
246	EU 29	98.10-98.00	-	4	19.8	Bison size	-	Long bone	-	Medial	-	1	3	-	-	-	-	-	rodent chewed
246	EU 29	98.10-98.00	-	1	1.1	Rabbit size	-	Long bone	-	Medial	-	-	1	-	-	-	-	-	-
246	EU 29	98.10-98.00	-	9	22.5	Bison size	-	Rib	-	Medial	-	4	2	1	2	-	-	-	rodent chewed
247	EU 29	98.00-97.90	-	3	6.2	Deer size	-	Rib	-	Medial	-	-	3	-	-	-	-	-	-
247	EU 29	98.00-97.90	-	1	2.2	Bison size	-	-	-	Frags	-	1	-	-	-	-	-	-	-
247	EU 29	98.00-97.90	-	2	3.0	Deer size	-	Long bone	-	Medial	-	2	-	-	-	-	-	-	-
247	EU 29	98.00-97.90	-	5	1.7	Turtle	-	Carapace	-	Medial	-	5	-	-	-	-	-	-	-
247	EU 29	98.00-97.90	-	30	8.7	Indeterminate	-	-	-	Frags	-	30	-	-	-	-	-	-	-
248	EU 29	97.90-97.80	-	3	0.9	Indeterminate	-	-	-	Frags	-	2	1	-	-	-	-	-	-
249	EU 30	98.22-98.10	-	1	0.2	Indeterminate	-	-	-	Frags	-	1	-	-	-	-	-	-	-
250	EU 30	98.11-98.00	-	5	5.0	Indeterminate	-	-	-	Frags	-	4	1	-	-	-	-	-	-
251	EU 30	98.00-97.90	-	1	11.4	Deer size	-	Astragalus	-	Complete	L	-	1	-	-	-	-	-	-
251	EU 30	98.00-97.90	-	2	4.2	Bison size	-	Long bone	fetal	Medial	-	2	-	-	-	-	-	-	-
251	EU 30	98.00-97.90	-	2	12.2	Bison size	-	Cancellous	-	Medial	-	-	2	-	-	-	-	-	-
251	EU 30	98.00-97.90	-	4	9.3	Deer size	-	Long bone	-	Medial	-	1	3	-	-	-	-	-	-
251	EU 30	98.00-97.90	-	25	10.6	Indeterminate	-	-	-	Frags	-	23	2	-	-	-	1 black, 1 white	-	-
251	EU 30	98.00-97.90	-	2	0.8	Rabbit size		Long bone	-	Medial	-	1	1	-	-	-	-	-	-
251	EU 30	98.00-97.90	-	2	0.8	Indeterminate	-	-	-	Frags	-	2	-	-	-	-	1 black, 1 white	-	-
252	EU 30	97.90-97.80	-	1	1.4	Deer size	-	Rib	-	Medial	-	1	-	-	-	-	-	-	-
252	EU 30	97.90-97.80	-	3	0.6	Indeterminate	-	-	-	Frags	-	3	-	-	-	-	-	-	-
252	EU 30	97.90-97.80	-	1	1.4	Raccoon size	-	Mandible	-	Complete	R	1	-	-	-	-	-	-	1 tooth
252	EU 30	97.90-97.80	-	1	0.2	Bird size	-	Long bone	-	Medial	-	1	-	-	-	-	-	-	-
253	EU 31	98.20-98.10	-	1	15.7	Deer size	-	Metapodial	-	Medial	-	-	-	-	1	-	-	-	-
253	EU 31	98.20-98.10	-	1	0.2	Indeterminate	-	-	-	Frags	-	1	-	-	-	-	-	-	fish skull?
254	EU 31	98.10-98.00	-	1	3.0	Deer size	-	Long bone	-	Medial	-	-	1	-	-	-	-	-	rodent chewed
254	EU 31	98.10-98.00	-	2	0.2	Indeterminate	-	-	-	Frags	-	2	-	-	-	-	-	-	-
255	EU 31	98.00-97.90	-	1	8.5	Bison size	-	Rib	-	Medial	-	-	-	1	-	-	-	-	-
255	EU 31	98.00-97.90	-	2	15.8	Bison size	-	Long bone	-	Medial	-	-	2	-	-	-	-	-	-
255	EU 31	98.00-97.90	-	12	11.6	Deer size	-	Rib	-	Medial	-	11	1	-	-	-	-	-	-
255	EU 31	98.00-97.90	-	1	0.6	Indeterminate	-	-	-	Frags	-	1	-	-	-	-	black	-	-
255	EU 31	98.00-97.90	-	13	2.0	Indeterminate	-	-	-	Frags	-	13	-	-	-	-	-	-	-
255	EU 31	98.00-97.90	-	1	0.1	Fish	-	Skull	-	Frags	-	1	-	-	-	-	-	-	-
256	EU 31	97.90-97.80	-	2	3.2	Deer size	-	Long bone	-	Medial	-	1	1	-	-	-	-	-	-
257	EU 32	98.25-98.10	-	7	3.7	Indeterminate	-	-	-	Frags	-	7	-	-	-	-	-	-	-

Appendix A, continued

Lot #	Unit	Elevation	Feature	Qty	Wt (g)	Taxon	Species	Element	Age	Portion	Side	Size, 0-3 cm	Size, 3-6 cm	Size, 6-9 cm	Size, 9-12 cm	Size, >12 cm	Burned (Color)	Cut Marks (Type)	Comments
258	EU 32	98.10-98.00	-	1	2.1	Deer size	-	Long bone	-	Medial	-	-	1	-	-	-	-	-	-
258	EU 32	98.10-98.00	-	1	0.1	Indeterminate	-	-	-	Frags	-	1	-	-	-	-	black	-	-
261	EU 33	98.20-98.10	-	1	5.6	Deer size	-	Long bone	-	Medial	-	-	1	-	-	-	-	-	-
262	EU 33	98.10-98.00	-	4	6.6	Deer size	-	Rib	-	Medial	-	1	2	1	-	-	-	-	-
262	EU 33	98.10-98.00	-	2	0.5	Indeterminate	-	-	-	Frags	-	2	-	-	-	-	2 black	-	-
262	EU 33	98.10-98.00	-	15	4.0	Indeterminate	-	-	-	Frags	-	15	-	-	-	-	-	-	-
263	EU 33	98.00-97.90	-	1	15.9	Bison size	-	Long bone	-	Distal		-	1	-	-	-	-	-	-
263	EU 33	98.00-97.90	-	1	1.1	Bison size	-	Long bone	-	Medial	-	1	-	-	-	-	-	-	-
265	EU 33	97.80-97.70	-	1	0.5	Rodent size	-	Mandible	-	Medial	R	1	-	-	-	-	-	-	-
266	EU 34	98.20-98.10	-	3	1.1	Indeterminate	-	-	-	Frags	-	3	-	-	-	-	1 black	-	-
267	EU 34	98.10-98.00	-	2	4.4	Deer size	-	Long bone	-	Medial	-	1	1	-	-	-	-	-	-
267	EU 34	98.10-98.00	-	2	0.5	Indeterminate	-	-	-	Frags	-	2	-	-	-	-	-	-	-
268	EU 34	98.00-97.90	-	1	1.5	Deer size	-	3rd Phalange	-	Complete	-	1	-	-	-	-	-	-	-
268	EU 34	98.00-97.90	-	2	1.6	Deer size	-	Phalange	-	Distal	-	2	-	-	-	-	-	-	butchered
268	EU 34	98.00-97.90	-	2	0.3	Rodent size	-	Tooth, incisor	-	Complete	-	2	-	-	-	-	-	-	-
268	EU 34	98.00-97.90	-	2	2.9	Deer size	-	Long bone	-	Medial	-	2	-	-	-	-	-	-	-
268	EU 34	98.00-97.90	-	1	3.4	Bison size	-	Rib	-	Medial	-	-	1	-	-	-	-	8+ thin	-
268	EU 34	98.00-97.90	-	15	3.5	Indeterminate	-	-	-	Frags	-	15	-	-	-	-	-	-	-
268	EU 34	98.00-97.90	-	1	1.0	Bird	-	Long bone	-	Medial	-	-	1	-	-	-	-	-	-
269	EU 35	98.22-98.10	-	1	1.7	Deer size	-	Long bone	-	Medial	-	1	-	-	-	-	-	-	-
269	EU 35	98.22-98.10	-	1	1.6	Indeterminate	-	Skull	-	Frags	-	1	-	-	-	-	-	-	-
270	EU 35	98.10-98.00	-	1	9.6	Bison	-	Tooth, maxillary	-	Complete	-	-	1	-	-	-	-	-	top broken
270	EU 35	98.10-98.00	-	1	0.4	Canid	-	Tooth	-	Complete	-	1	-	-	-	-	-	-	-
270	EU 35	98.10-98.00	-	1	2.5	Deer size	-	Long bone	-	Medial	-	-	1	-	-	-	gray	-	spiral fractured
270	EU 35	98.10-98.00	-	1	0.5	Turtle	-	Carapace	-	Medial	-	1	-	-	-	-	-	-	-
270	EU 35	98.10-98.00	-	1	1.4	Bison size	-	Rib	-	Medial	-	-	1	-	-	-	-	-	-
270	EU 35	98.10-98.00	-	7	3.7	Indeterminate	-	-	-	Frags	-	6	1	-	-	-	-	-	-
271	EU 35	98.00-97.90	-	1	3.3	Bison	-	Rib	-	Head proximal	-	1	-	-	-	-	-	-	-
271	EU 35	98.00-97.90	-	1	0.2	Indeterminate	-	Rib	-	Medial	-	1	-	-	-	-	white	-	-
271	EU 35	98.00-97.90	-	12	5.3	Indeterminate	-	-	-	Frags	-	12	-	-	-	-	-	-	-
271	EU 35	98.00-97.90	-	2	0.3	Rabbit size	-	Long bone	-	Medial	-	2	-	-	-	-	-	-	-
271	EU 35	98.00-97.90	-	3	6.3	Deer size	-	Long bone	-	Medial	-	1	2	-	-	-	-	-	-
273	EU 36	98.18-98.10	-	1	0.1	Indeterminate	-	-	-	Frags	-	1	-	-	-	-	-	-	-
274	EU 36	98.11-98.00	-	1	0.7	Turtle	-	Carapace	-	Medial	-	1	-	-	-	-	-	-	-
274	EU 36	98.11-98.00	-	1	3.6	Deer	-	Tooth, M1	-	Complete	L	1	-	-	-	-	-	-	-
274	EU 36	98.11-98.00	-	1	8.1	Bison size	-	Long bone	-	Medial	-	-	-	1	-	-	-	-	water rounded
274	EU 36	98.11-98.00	-	1	0.5	Indeterminate	-	Long bone	-	Medial	-	1	-	-	-	-	white/black	-	-
274	EU 36	98.11-98.00	-	12	5.4	Indeterminate	-	-	-	Frags	-	12	-	-	-	-	-	-	-
275	EU 36	98.00-97.90	-	1	8.6	Deer size	-	Metatarsal	-	Proximal	R	-	-	1	-	-	-	-	impact fracture
275	EU 36	98.00-97.90	-	1	6.3	Deer size	-	Long bone	-	Medial	-	-	-	1	-	-	-	-	spiral fractured, impact fracture
275	EU 36	98.00-97.90	-	1	2.6	Deer size	-	Tooth, P1, P2	med	Complete	R	1	-	-	-	-	-	-	medium, some wear
275	EU 36	98.00-97.90	-	1	8.1	Bison size	-	Long bone	-	Medial	-	-	1	-	-	-	-	-	-

Appendix A, continued

Lot #	Unit	Elevation	Feature	Qty	Wt (g)	Taxon	Species	Element	Age	Portion	Side	Size, 0-3 cm	Size, 3-6 cm	Size, 6-9 cm	Size, 9-12 cm	Size, >12 cm	Burned (Color)	Cut Marks (Type)	Comments
275	EU 36	98.00-97.90	-	1	0.5	Fish	-	Vertebra	-	Complete	-	1	-	-	-	-	-	-	large 1 cm, catfishlike
275	EU 36	98.00-97.90	-	22	7.4	Indeterminate	-	-	-	Frags	-	22	-	-	-	-	1 brown		-
275	EU 36	98.00-97.90	-	1	0.1	Rabbit size	-	Long bone	-	Medial	-	1	-	-	-	-	-	-	-
277	EU 37	98.30-98.20	-	1	6.2	Bison	-	Rib	-	Medial	-	-	-	-	1	-	-	multi cuts	rodent chewed
277	EU 37	98.30-98.20	-	7	5.5	Indeterminate	-	-	-	Frags	-	7	-	-	-	-	-	-	-
278	EU 37	98.20-98.10	-	2	4.2	Deer size	-	Long bone	-	Medial	-	1	1	-	-	-	brown	-	spiral fractured
278	EU 37	98.20-98.10	-	9	9.3	Deer size	-	Rib	-	Medial	-	7	1	1	-	-	-	-	-
278	EU 37	98.20-98.10	-	1	4.7	Indeterminate	-	Long bone	-	Medial	-	-	1	-	-	-	-	-	-
279	EU 37	98.10-98.00	-	1	7.2	Bison size	-	Long bone	-	Medial	-	1	-	-	-	-	-	8 thin cuts	-
279	EU 37	98.10-98.00	-	1	51.2	Bison size	-	Tooth, maxillary	med	Complete	L	-	1	-	-	-	-	-	-
279	EU 37	98.10-98.00	-	1	0.4	Fish	-	Skull	-	Frags	-	1	-	-	-	-	-	-	-
279	EU 37	98.10-98.00	-	8	8.6	Deer size	-	Long bone	-	Medial	-	7	1	-	-	-	-	-	-
279	EU 37	98.10-98.00	-	18	4.5	Indeterminate	-	-	-	Frags	-	18	-	-	-	-	-	-	-
279	EU 37	98.10-98.00	-	1	2.2	Bison size	-	Rib	-	Medial	-	1	-	-	-	-	-	-	-
280	EU 37	98.00-97.90	-	2	16.4	Deer size	-	Long bone	-	Medial	-	-	-	1	1	-	-	-	-
280	EU 37	98.00-97.90	-	4	3.5	Indeterminate	-	Cancellous	-	Medial	-	4	-	-	-	-	-	-	-
280	EU 37	98.00-97.90	-	18	8.6	Indeterminate	-	Long bone	-	Medial	-	18	-	-	-	-	-	-	-
282	EU 38	98.29-98.20	-	1	0.2	Indeterminate	-	-	-	Frags	-	1	-	-	-	-	-	-	-
283	EU 38	98.20-98.10	-	1	5.1	Bison size	-	Rib	-	Medial	-	-	-	1	-	-	-	-	water rounded
283	EU 38	98.20-98.10	-	2	4.6	Deer size	-	Long bone	-	Medial	-	2	-	-	-	-	-	-	-
283	EU 38	98.20-98.10	-	8	1.8	Indeterminate	-	-	-	Frags	-	8	-	-	-	-	1 black	-	-
284	EU 38	98.10-98.00	-	1	0.4	Rabbit size	-	Long bone	-	Medial	-	-	1	-	-	-	-	-	-
284	EU 38	98.10-98.00	-	1	3.1	Bison size	-	Long bone	-	Medial	-	-	1	-	-	-	-	-	-
284	EU 38	98.10-98.00	-	6	5.8	Indeterminate	-	-	-	Frags	-	4	2	-	-	-	-	-	-
286	EU 39	98.10-98.00	-	1	2.4	Bison size	-	Long bone	-	Medial	-	1	-	-	-	-	-	-	-
286	EU 39	98.10-98.00	-	1	0.7	Deer size	-	Long bone	-	Medial	-	1	-	-	-	-	-	-	-
287	EU 39	98.00-97.90	-	1	2.3	Deer	-	Tooth, M2	med	3/4 Complete	R	1	-	-	-	-	-	-	-
287	EU 39	98.00-97.90	-	1	3.7	Bison size	-	Long bone	-	Medial	-	-	1	-	-	-	-	-	-
287	EU 39	98.00-97.90	-	34	20.2	Indeterminate	-	-	-	Frags	-	29	5	-	-	-	-	-	-
288	EU 39	97.80-97.70	-	1	1.1	Deer size	-	Rib	-	Medial	-	1	-	-	-	-	-	-	-
289	EU 40	98.06-98.00	-	2	6.3	Deer size	-	Long bone	-	Medial	-	-	2	-	-	-	-	-	-
289	EU 40	98.06-98.00	-	2	19.1	Bison size	-	Long bone	-	Medial	-	-	1	1	-	-	-	-	-
289	EU 40	98.06-98.00	-	2	2.6	Bison size	-	Rib	-	Medial	-	2	-	-	-	-	-	-	-
289	EU 40	98.06-98.00	-	1	5.3	Bison size	-	Cancellous	-	Medial	-	1	-	-	-	-	-	-	-
289	EU 40	98.06-98.00	-	14	7.3	Indeterminate	-	-	-	Frags	-	12	2	-	-	-	-	-	-
290	EU 40	98.00-97.90	-	2	8.5	Bison size	-	Rib	-	Medial	-	-	1	-	-	-	-	lots of thin cuts	rodent chewed
290	EU 40	98.00-97.90	-	1	7.3	Bison size	-	Long bone	-	Medial	-	1	-	-	-	-	-	-	-
290	EU 40	98.00-97.90	-	9	14.0	Deer size	-	-	-	Frags	-	6	2	1	-	-	-	-	-
290	EU 40	98.00-97.90	-	2	1.0	Deer size	-	-	-	Frags	-	2	-	-	-	-	2 black	-	-
290	EU 40	98.00-97.90	-	1	0.1	Rabbit size	-	Long bone	-	Medial	-	1	-	-	-	-	1 black	-	spiral fractured
290	EU 40	98.00-97.90	-	27	7.7	Indeterminate	-	-	-	Frags	-	25	2	-	-	-	-	-	-
291	EU 40	97.90-97.80	-	2	0.3	Indeterminate	-	-	-	Frags	-	2	-	-	-	-	-	-	-
292	EU 40	97.80-97.70	-	1	0.1	Indeterminate	-	-	-	Frags	-	1	-	-	-	-	-	-	-
293	EU 41	98.21-98.10	-	4	0.8	Indeterminate	-	-	-	Frags	-	4	-	-	-	-	-	-	-
294	EU 41	98.10-98.00	-	1	0.2	Rodent size	-	Tooth, incisor	-	Complete	-	1	-	-	-	-	-	-	-

Appendix A, continued

Lot #	Unit	Elevation	Feature	Qty	Wt (g)	Taxon	Species	Element	Age	Portion	Side	Size, 0-3 cm	Size, 3-6 cm	Size, 6-9 cm	Size, 9-12 cm	Size, >12 cm	Burned (Color)	Cut Marks (Type)	Comments
294	EU 41	98.10-98.00	-	10	7.2	Indeterminate	-	-	-	Frags	-	8	2	-	-	-	-	-	-
295	EU 39	97.90-97.80	-	2	476.5	Bison	-	Femur	-	Distal	L	-	1	-	-	1	-	-	weathered, spiral fractured, rodent chewed
295	EU 39	97.90-97.80	-	6	2.7	Indeterminate	-	-	-	Frags	-	6	-	-	-	-	1 black	-	-
295	EU 39	97.90-97.80	-	1	8.7	Bison size	-	Rib	-	Medial	-	-	1	-	-	-	-	-	grooves at snap end
296	EU 41	98.00-97.90	-	1	9.7	Bison size	-	Long bone	-	Medial	-	-	1	-	-	-	-	-	-
296	EU 41	98.00-97.90	-	1	5.3	Bison size	-	Sesimoid	-	Complete	-	1	-	-	-	-	-	-	-
296	EU 41	98.00-97.90	-	1	3.7	Deer size	-	Metapodial	-	Distal	-	1	-	-	-	-	partially black	-	-
296	EU 41	98.00-97.90	-	1	0.2	Rabbit size	-	Long bone	-	Medial	-	1	-	-	-	-	-	-	-
296	EU 41	98.00-97.90	-	14	6.3	Indeterminate	-	-	-	Frags	-	13	1	-	-	-	-	-	-
297	EU 41	97.94	-	2	81.1	Bison	-	Rib	-	Medial	-	-	-	-	-	2	-	scattered	rodent chewed, weathered
298	EU 41	97.90-97.80	-	1	0.1	Indeterminate	-	-	-	Frags	-	1	-	-	-	-	-	-	-
298	EU 41	97.90-97.80	-	2	2.6	Fish	Catfish	Skull	-	Frags	-	1	1	-	-	-	-	-	-
299	EU 42	98.23-98.10	-	1	1.6	Indeterminate	-	Long bone	-	-	-	1	-	-	-	-	black	-	unusual
299	EU 42	98.23-98.10	-	2	2.4	Indeterminate	-	Rib	-	Frags	-	2	-	-	-	-	-	-	-
300	EU 42	98.10-98.00	-	1	3.6	Bison size	-	Long bone	-	Medial	-	1	-	-	-	-	-	-	-
300	EU 42	98.10-98.00	-	2	0.4	Indeterminate	-	-	-	Frags	-	2	-	-	-	-	-	-	-
300	EU 42	98.10-98.00	-	2	0.3	Rabbit size	-	Long bone	-	Medial	-	2	-	-	-	-	-	-	-
300-2	EU 42	98.10-98.00	-	1	0.9	Indeterminate	-	-	-	Frags	-	1	-	-	-	-	brown	-	-
301	EU 42	98.00-97.90	-	1	6.4	Deer	-	Tibia	immature	Distal	R	1	-	-	-	-	-	-	unfused
301	EU 42	98.00-97.90	-	8	9.2	Deer size	-	Rib	-	Medial	-	7	1	-	-	-	-	-	-
301	EU 42	98.00-97.90	-	6	1.8	Indeterminate	-	-	-	Frags	-	6	-	-	-	-	-	-	-
304	EU 43	98.00-97.90	-	7	4.5	Deer size	-	Rib	-	Medial	-	4	2	1	-	-	-	-	-
304	EU 43	98.00-97.90	-	6	6.8	Deer size	-	Long bone	-	Medial	-	4	2	-	-	-	-	-	-
304	EU 43	98.00-97.90	-	1	0.1	Indeterminate	-	Long bone	-	Medial	-	1	-	-	-	-	black	-	-
304	EU 43	98.00-97.90	-	16	3.1	Indeterminate	-	-	-	Frags	-	16	-	-	-	-	-	-	-
305	EU 43	97.90-97.80	-	1	36.5	Bison	-	Femur	immature	Proximal	L	-	1	-	-	-	-	chop marks	cap only unfused
305	EU 43	97.90-97.80	-	9	20.3	Bison	-	Rib	-	Medial	-	5	3	1	-	-	-	-	-
305	EU 43	97.90-97.80	-	2	4.1	Deer size	-	Rib	-	Medial	-	-	2	-	-	-	-	-	-
305	EU 43	97.90-97.80	-	8	1.8	Indeterminate	-	-	-	Frags	-	8	-	-	-	-	7 black, 1 white	-	-
305	EU 43	97.90-97.80	-	52	15.8	Indeterminate	-	-	-	Frags	-	52	-	-	-	-	-	-	-
305	EU 43	97.90-97.80	-	1	0.2	Turtle	-	Carapace	-	Medial	-	1	-	-	-	-	-	-	-
306	EU 43	97.80-97.70	-	2	1.8	Indeterminate	-	-	-	Frags	-	2	-	-	-	-	-	-	-
307	EU 43	97.70-97.60	-	2	0.1	Rodent	-	Mandible	-	Complete	R	2	-	-	-	-	-	-	-
308	EU 44	98.11-98.00	-	2	2.4	Deer size	-	Rib	-	Medial	-	1	1	-	-	-	-	-	-
308	EU 44	98.11-98.00	-	1	0.3	Deer size	-	Dew claw	-	Complete	-	1	-	-	-	-	-	-	-
308	EU 44	98.11-98.00	-	4	4.5	Deer size	-	Rib	-	Medial	-	-	4	-	-	-	-	-	-
308	EU 44	98.11-98.00	-	30	10.1	Indeterminate	-	-	-	Frags	-	29	1	-	-	-	-	-	-
308	EU 44	98.11-98.00	-	6	1.9	Rabbit size	-	Long bone	-	Medial	-	6	-	-	-	-	-	-	-

Appendix A, continued

Lot #	Unit	Elevation	Feature	Qty	Wt (g)	Taxon	Species	Element	Age	Portion	Side	Size, 0-3 cm	Size, 3-6 cm	Size, 6-9 cm	Size, 9-12 cm	Size, >12 cm	Burned (Color)	Cut Marks (Type)	Comments
308	EU 44	98.11-98.00	-	1	0.3	Fish	-	Skull	-	Frags	-	1	-	-	-	-	-	-	-
310	EU 44	97.90-97.80	-	6	54.3	Bison	-	Rib	-	Medial	-	-	-	4	-	2	-	multi cut mark on 2 bones	-
310	EU 44	97.90-97.80	-	2	0.7	Rabbit size	-	Long bone	-	Medial	-	2	-	-	-	-	-	-	-
310	EU 44	97.90-97.80	-	1	0.5	Turtle	-	Carapace	-	Medial	-	1	-	-	-	-	black	-	-
310	EU 44	97.90-97.80	-	1	0.2	Fish	-	Skull	-	Medial	-	1	-	-	-	-	-	-	-
310	EU 44	97.90-97.80	-	29	19.5	Indeterminate	-	Rib	-	Frags	-	26	3	-	-	-	-	-	-
311	EU 44	97.80-97.70	-	1	0.3	Indeterminate	-	Rib	-	Frags	-	1	-	-	-	-	-	-	-
312	EU 45	98.02-97.90	-	1	93.4	Bison	-	Tibia	-	Distal	R	-	-	-	-	1	-	-	spiral fractured, rodent chewed
312	EU 45	98.02-97.90	-	18	16.8	Indeterminate	-	-	-	Frags	-	11	7	-	-	-	-	-	-
313	EU 45	97.90-97.80	-	11	10.2	Deer size	-	Long bone	-	Medial	-	9	2	-	-	-	-	-	-
314	EU 45	97.80-97.70	-	1	7.7	Bison size	-	Long bone	-	Medial	-	-	1	-	-	-	-	-	-
315	EU 46	98.00-97.90	-	6	5.1	Deer size	-	Long bone	-	Medial	-	6	-	-	-	-	-	-	-
315	EU 46	98.00-97.90	-	1	0.1	Indeterminate	-	-	-	Frags	-	1	-	-	-	-	-	-	-
316	EU 46	97.90-97.80	-	2	19.2	Bison	-	Radius	immature	Distal	-	-	1	-	-	-	-	-	unfused, rodent chewed
316	EU 46	97.90-97.80	-	3	4.0	Deer size	-	Long bone	-	Medial	-	2	1	-	-	-	-	-	-
316	EU 46	97.90-97.80	-	1	0.1	Deer	-	Antler	-	Distal	-	1	-	-	-	-	white	-	-
316	EU 46	97.90-97.80	-	24	13.9	Deer size	-	Rib	-	Frags	-	22	2	-	-	-	-	-	-
316	EU 46	97.90-97.80	-	1	0.1	Bird	-	Humerus	-	Distal	L	1	-	-	-	-	-	-	small
316	EU 46	97.90-97.80	-	7	1.2	Rabbit size	-	Long bone	-	Medial	-	7	-	-	-	-	2 black	-	-
316	EU 46	97.90-97.80	-	1	0.1	Rabbit size	-	Femur	-	Proximal	L	1	-	-	-	-	-	-	-
316	EU 46	97.90-97.80	-	2	1.9	Indeterminate	-	-	-	Frags	-	2	-	-	-	-	1 white	-	-
317	EU 46	97.80-97.70	-	2	1.2	Fish	Catfish	Spine	-	Medial	-	2	-	-	-	-	-	-	large fish, 2 pieces, same spine
317	EU 46	97.80-97.70	-	3	1.8	Fish	Catfish	Skull	-	Medial	-	3	-	-	-	-	-	-	-
317	EU 46	97.80-97.70	-	1	0.1	Fish	-	Vertebra	-	Frags	-	1	-	-	-	-	-	-	-
317	EU 46	97.80-97.70	-	9	12.1	Deer size	-	Rib	-	Frags	-	7	2	-	-	-	-	-	-
317	EU 46	97.80-97.70	-	3	1.6	Rabbit size	-	Long bone	-	Medial	-	2	1	-	-	-	-	-	-
317	EU 46	97.80-97.70	-	5	1.2	Indeterminate	-	-	-	Frags	-	5	-	-	-	-	-	-	-
318	EU 46	97.75	-	1	109.7	Bison	-	Femur	-	Distal	R	-	-	-	1	-	-	-	half
319	EU 46	97.74	-	1	3.6	Deer size	-	Long bone	-	Medial	-	-	1	-	-	-	-	-	-
320	EU 46	97.73	-	4	19.1	Bison size	-	Rib	-	Medial	-	2	1	-	1	-	-	-	-
320	EU 46	97.73	-	1	4.5	Bison size	-	Indeterminate	-	Frags	-	1	-	-	-	-	white/black	-	-
321	EU 47	98.02-97.90	-	8	9.1	Deer size	-	Long bone	-	Medial	-	6	2	-	-	-	-	-	-
322	EU 47	97.90-97.80	-	6	4.2	Deer size	-	Long bone	-	Medial	-	5	1	-	-	-	-	-	-
323	EU 47	97.80-97.70	-	2	2.3	Fish	Catfish	Vertebra	-	Complete	-	2	-	-	-	-	-	-	1 large catfsh size, 1 med size
323	EU 47	97.80-97.70	-	1	1.1	Deer size	-	Skull	-	Frags	-	1	-	-	-	-	-	-	-
323	EU 47	97.80-97.70	-	2	1.5	Fish	-	Skull	-	Frags	-	1	1	-	-	-	-	-	-
323	EU 47	97.80-97.70	-	1	0.2	Rabbit size	-	Long bone	-	Medial	-	1	-	-	-	-	-	-	-
323	EU 47	97.80-97.70	-	22	12.6	Deer size	-	Long bone	-	Medial	-	19	3	-	-	-	-	-	-
323	EU 47	97.80-97.70	-	2	3.8	Bison size	-	Rib	-	Medial	-	-	2	-	-	-	-	-	-
323	EU 47	97.80-97.70	-	1	4.1	Bison size	-	Long bone	-	Medial	-	1	-	-	-	-	-	-	-

Appendix A, continued

Lot #	Unit	Elevation	Feature	Qty	Wt (g)	Taxon	Species	Element	Age	Portion	Side	Size, 0-3 cm	Size, 3-6 cm	Size, 6-9 cm	Size, 9-12 cm	Size, >12 cm	Burned (Color)	Cut Marks (Type)	Comments
324	EU 47	97.70-97.60	-	1	0.3	Indeterminate	-	-	-	Frags	-	1	-	-	-	-	-	-	-
325	EU 47	97.90-97.80	-	1	8.6	Deer size	-	Femur	-	Distal	L	-	1	-	-	-	-	-	-
325	EU 47	97.90-97.80	-	5	1.5	Indeterminate	-	Rib	-	Medial	-	5	-	-	-	-	1 white	-	-
326	EU 48	97.80-97.70	-	1	1.1	Deer size	-	2nd phalange	-	Distal	-	1	-	-	-	-	-	-	butchered
326	EU 48	97.80-97.70	-	22	9.6	Deer size	-	Rib	-	Medial	-	20	2	-	-	-	-	-	-
326	EU 48	97.80-97.70	-	3	10.8	Bison size	-	Rib	-	Medial	-	-	2	1	-	-	-	-	-
326	EU 48	97.80-97.70	-	2	0.2	Rabbit size	-	Long bone	-	Medial	-	2	-	-	-	-	2 black	-	-
328	EU 49	98.10-98.00	-	3	1.0	Deer size	-	Rib	-	Frags	-	-	-	-	-	-	3 black	-	-
328	EU 49	98.10-98.00	-	13	9.9	Deer size	-	Rib	-	Medial	-	12	-	1	-	-	-	-	-
328	EU 49	98.10-98.00	-	2	10.7	Deer size	-	Long bone	-	Medial	-	-	2	-	-	-	-	mult cuts	-
328	EU 49	98.10-98.00	-	1	3.0	Bison size	-	Rib	-	Medial	-	-	1	-	-	-	-	-	tool
328	EU 49	98.10-98.00	-	1	1.0	Indeterminate	-	Indeterminate	-	Frags	-	1	-	-	-	-	-	-	-
328	EU 49	98.10-98.00	-	1	1.0	Indeterminate	-	-	-	Medial	-	1	-	-	-	-	-	-	medial awl
329	EU 49	98.00-97.90	-	1	0.4	Indeterminate	-	-	-	Frags	-	1	-	-	-	-	-	-	-
330	EU 49	97.90-97.80	-	3	7.0	Deer size	-	Long bone	-	Medial	-	-	3	-	-	-	-	-	-
330	EU 49	97.90-97.80	-	2	0.1	Indeterminate	-	-	-	Frags	-	2	-	-	-	-	-	-	-
333	EU 50	98.10-98.00	-	1	11.2	Bison size	-	Rib	-	Medial	-	-	-	-	-	1	-	-	spiral fractured
333	EU 50	98.10-98.00	-	1	1.2	Turtle	-	Carapace	-	Lateral	-	1	-	-	-	-	-	-	-
333	EU 50	98.10-98.00	-	1	0.7	Deer size	-	Rib	-	Medial	-	1	-	-	-	-	-	thin cuts	-
333	EU 50	98.10-98.00	-	2	0.4	Indeterminate	-	-	-	Frags	-	2	-	-	-	-	1 black	-	-
333	EU 50	98.10-98.00	-	1	0.2	Indeterminate	-	-	-	Frags	-	1	-	-	-	-	-	-	tool frag, medial section of an awl
333	EU 50	98.10-98.00	-	1	0.2	Indeterminate	-	-	-	Medial	-	1	-	-	-	-	-	-	medial awl
334	EU 50	98.00-97.90	-	1	0.3	Indeterminate	-	-	-	Frags	-	1	-	-	-	-	black	-	-
334	EU 50	98.00-97.90	-	1	0.3	Deer size	-	Vertebra cap	-	-	-	1	-	-	-	-	-	-	-
334	EU 50	98.00-97.90	-	1	14.1	Deer size	-	Long bone	-	Medial	-	-	-	1	-	-	-	-	spiral fractured
334	EU 50	98.00-97.90	-	13	2.9	Indeterminate	-	-	-	Frags	-	13	-	-	-	-	-	-	-
335	EU 48	98.00-97.90	-	1	3.6	Bison size	-	Vertebra	-	Medial	-	-	1	-	-	-	-	-	-
335	EU 48	98.00-97.90	-	2	0.6	Indeterminate	-	-	-	Frags	-	2	-	-	-	-	-	-	-
336	EU 51	98.20-98.10	-	2	9.5	Deer size	-	Long bone	-	Medial	-	-	2	-	-	-	-	-	spiral fractured
336	EU 51	98.20-98.10	-	5	1.9	Indeterminate	-	-	-	Frags	-	5	-	-	-	-	-	-	-
337	EU 51	98.31-98.20	-	1	0.8	Deer size	-	Long bone	-	Medial	-	-	-	1	-	-	-	-	-
337	EU 51	98.31-98.20	-	1	0.5	Indeterminate	-	-	-	Frags	-	1	-	-	-	-	-	-	-
338	EU 51	98.10-98.00	-	2	42.2	Bison size	-	Rib	-	Medial	-	-	-	-	-	2	-	-	weathered
338	EU 51	98.10-98.00	-	1	104.3	Bison size	-	Femur	-	Distal	R	-	-	-	-	1	-	-	spiral fractured, weathered, rodent chewed
338	EU 51	98.10-98.00	-	1	1.0	Bison size	-	1st Phalange	Newborn	Complete	-	1	-	-	-	-	-	-	-
338	EU 51	98.10-98.00	-	1	0.3	Rodent	-	Maxilla	-	Frags	L	1	-	-	-	-	-	-	-
338	EU 51	98.10-98.00	-	9	2.4	Indeterminate	-	-	-	Frags	-	8	1	-	-	-	-	-	-
339	EU 51	98.00-97.90	-	1	0.4	Indeterminate	-	-	-	Frags	-	1	-	-	-	-	-	-	-
340	EU 52	98.36-98.30	-	1	0.2	Rodent	-	Tooth	-	Complete	-	1	-	-	-	-	-	-	-
340	EU 52	98.36-98.30	-	1	1.2	Indeterminate	-	Long bone	-	Medial	-	1	-	-	-	-	-	-	-
341	EU 52	98.30-98.20	-	6	5.5	Deer size	-	Long bone	-	Medial	-	5	1	-	-	-	-	-	-
341-7	EU 52	98.30-98.20	-	1	0.3	Indeterminate	-	Long bone	-	Frags	-	1	-	-	-	-	black	-	incisor

Appendix A, continued

Lot #	Unit	Elevation	Feature	Qty	Wt (g)	Taxon	Species	Element	Age	Portion	Side	Size, 0-3 cm	Size, 3-6 cm	Size, 6-9 cm	Size, 9-12 cm	Size, >12 cm	Burned (Color)	Cut Marks (Type)	Comments
342	EU 52	98.20-98.10	-	5	1.3	Indeterminate	-	-	-	Frags	-	5	-	-	-	-	2 white, 3 black	-	-
342	EU 52	98.20-98.10	-	3	3.5	Deer size	-	Long bone	-	Medial	-	3	-	-	-	-	-	-	-
342	EU 52	98.20-98.10	-	6	1.8	Indeterminate	-	-	-	Frags	-	6	-	-	-	-	-	-	-
343	EU 52	98.10-98.00	-	2	7.4	Deer size	-	Long bone	-	Medial	-	-	2	-	-	-	-	-	-
343	EU 52	98.10-98.00	-	1	0.1	Indeterminate	-	Long bone	fetal	Medial	-	1	-	-	-	-	-	-	-
344	EU 53	98.44-98.30	-	10	5.7	Indeterminate	-	Rib	-	Medial	-	9	1	-	-	-	-	-	-
345	EU 53	98.44-98.30	-	3	6.2	Deer size	-	Long bone	-	Medial	-	2	1	-	-	-	-	-	-
345	EU 53	98.44-98.30	-	1	2.1	Bird	-	Long bone	-	-	-	-	1	-	-	-	-	mult cuts	turkey size
345	EU 53	98.44-98.30	-	10	2.6	Indeterminate	-	-	-	Frags	-	10	-	-	-	-	-	-	-
345	EU 53	98.44-98.30	-	1	1.2	Canid	Raccoon	Tooth, M2	-	Maxillary	-	1	-	-	-	-	-	-	-
346	EU 53	98.20-98.10	-	1	8.6	Bison size	-	Rib	-	Medial	-	-	-	-	1	-	-	-	-
346	EU 53	98.20-98.10	-	1	2.8	Deer size	-	Long bone	-	Medial	-	-	1		-	-	-	-	-
346	EU 53	98.20-98.10	-	3	1.1	Indeterminate	-	-	-	Frags	-	3	-	-	-	-	-	2 thin	-
348	EU 54	98.46-98.40	-	1	0.3	Indeterminate	-	-	-	Frags	-	1	-	-	-	-	-	-	-
349	EU 54	98.40-98.30	-	1	6.1	Bison size	-	Rib	-	Frags	-	-	-	1	-	-	-	many cuts	-
349	EU 54	98.40-98.30	-	6	2.1	Indeterminate	-	Rib	-	Frags	-	6	-	-	-	-	-	-	-
350	EU 54	98.30-98.20	-	3	2.3	Turtle	-	Carapace	-	Frags	-	3	-	-	-	-	-	-	edge
350	EU 54	98.30-98.20	-	2	0.6	Rabbit size	-	Long bone	-	Medial	-	2	-	-	-	-	-	-	-
350	EU 54	98.30-98.20	-	1	4.2	Bison size	-	Rib	-	Medial	-	-	1	-	-	-	-	cut lines	-
350	EU 54	98.30-98.20	-	3	10.6	Deer size	-	Long bone	-	Medial	-	2	-	1	-	-	-	-	spiral fractured
350	EU 54	98.30-98.20	-	4	3.3	Deer size	-	Rib	-	Frags	-	1	3	-	-	-	-	-	-
350	EU 54	98.30-98.20	-	20	6.1	Indeterminate	-	-	-	Frags	-	20	-	-	-	-	-	-	-
352	EU 55	98.19-98.10	-	2	1.1	Indeterminate	-	-	-	Frags	-	2	-	-	-	-	-	-	-
353	EU 55	98.10-98.00	-	1	0.2	Rabbit size	-	Long bone	-	Medial	-	1	-	-	-	-	-	-	-
353	EU 55	98.10-98.00	-	1	2.1	Deer size	-	Long bone	-	Medial	-	-	1	-	-	-	-	cuts	-
353	EU 55	98.10-98.00	-	5	11.0	Bison size	-	Rib	-	Medial	-	-	5	-	-	-	-	-	-
353	EU 55	98.10-98.00	-	29	13.2	Indeterminate	-	-	-	Frags	-	26	3	-	-	-	-	-	-
354	EU 55	98.00-97.90	-	4	7.2	Bison size	-	Rib	-	Medial	-	1	3	-	-	-	-	-	-
357	EU 56	98.38-98.20	-	1	0.1	Deer size	-	Long bone	-	Medial	-	-	1	-	-	-	-	-	-
358	EU 56	98.20-98.10	-	1	3.9	Deer size	-	Long bone	-	Medial	-	-	1	-	-	-	-	-	rodent chewed
358	EU 56	98.20-98.10	-	1	0.2	Rabbit size	-	Long bone	-	Medial	-	1	-	-	-	-	-	-	-
358	EU 56	98.20-98.10	-	10	4.2	Indeterminate	-	-	-	Frags	-	9	1	-	-	-	-	-	-
359	EU 56	98.10-98.00	-	1	13.5	Deer size	-	Calcanium	immature	Complete	R	-	-	1	-	-	-	-	-
359	EU 56	98.10-98.00	-	1	5.6	Bison size	-	Rib	-	Medial	-	-	-	1	-	-	-	-	-
359	EU 56	98.10-98.00	-	2	14.6	Bison size	-	Long bone	-	Medial	-	2	-	-	-	-	-	-	-
359	EU 56	98.10-98.00	-	1	1.8	Deer size	-	Long bone	-	Medial	-	-	1	-	-	-	-	-	-
359	EU 56	98.10-98.00	-	1	2.6	Deer size	-	Rib	-	Medial	-	-	1	-	-	-	-	-	-
359	EU 56	98.10-98.00	-	15	7.4	Indeterminate	-	-	-	Frags	-	15	-	-	-	-	-	-	-
361	EU 56	98.43-98.30	-	1	0.8	Indeterminate	-	-	-	Frags	-	1	-	-	-	-	-	-	-
362	EU 57	98.43-98.30	-	2	0.3	Indeterminate	-	-	-	Frags	-	2	-	-	-	-	-	-	-
363	EU 57	98.20-98.10	-	1	4.5	Bird	-	Long bone	-	Medial	-	-	-	1	-	-	-	mult cuts	large bird-turkey size, spiral fractured
363	EU 57	98.20-98.10	-	6	0.9	Indeterminate	-	-	-	Frags	-	6	-	-	-	-	5 black, 1 white	-	-
363	EU 57	98.20-98.10	-	17	3.8	Indeterminate	-	-	-	Frags	-	17	-	-	-	-	-	-	-

Appendix A, continued

Lot #	Unit	Elevation	Feature	Qty	Wt (g)	Taxon	Species	Element	Age	Portion	Side	Size, 0-3 cm	Size, 3-6 cm	Size, 6-9 cm	Size, 9-12 cm	Size, >12 cm	Burned (Color)	Cut Marks (Type)	Comments
364	EU 57	98.10-98.00	-	1	9.0	Deer size	-	Navicular cuboid	-	Complete	L	1	-	-	-	-	-	-	-
364	EU 57	98.10-98.00	-	1	13.7	Deer size	-	Metatarsal	-	Proximal	L	-	1	-	-	-	-	-	spiral fractured, rodent chewed
364	EU 57	98.10-98.00	-	6	3.0	Indeterminate	-	-	-	Frags	-	6	-	-	-	-	-	-	-
365	EU 58	98.33-98.20	-	2	2.7	Indeterminate	-	-	-	Frags	-	1	-	1	-	-	-	-	-
366	EU 58	98.20-98.10	-	1	9.9	Deer size	-	Astragulus	-	Complete	L	-	1	-	-	-	-	-	-
366	EU 58	98.20-98.10	-	8	1.7	Indeterminate	-	Rib	-	Frags	-	8	-	-	-	-	-	-	-
367	EU 58	98.10-98.00	-	1	0.4	Turtle	-	Carapace	-	Medial	-	1	-	-	-	-	-	-	-
367	EU 58	98.10-98.00	-	6	1.4	Indeterminate	-	-	-	Frags	-	6	-	-	-	-	-	-	-
368	EU 58	98.00-97.90	-	1	0.4	Indeterminate	-	Skull	-	Frags	-	1	-	-	-	-	-	-	-
370	EU 59	98.30-98.20	-	1	0.1	Rabbit size	-	Long bone	-	Medial	-	1	-	-	-	-	black	-	-
370	EU 59	98.30-98.20	-	1	1.2	Deer size	-	Rib	-	Medial	-	-	1	-	-	-	-	-	-
370	EU 59	98.30-98.20	-	3	0.4	Indeterminate	-	-	-	Frags	-	3	-	-	-	-	-	-	-
372	EU 59	98.20-98.10	-	1	125.5	Bison	-	Metatarsal	-	Distal	L	-	-	-	-	1	-	-	massive rodent chewed, spiral fractured
372	EU 59	98.20-98.10	-	1	4.1	Deer size	-	Long bone	-	Medial	-	-	1	-	-	-	-	-	spiral fractured
372	EU 59	98.20-98.10	-	10	2.5	Indeterminate	-	-	-	Frags	-	9	1	-	-	-	1 black	-	-
374	EU 59	98.00-97.90	-	1	0.2	Indeterminate	-	-	-	Frags	-	1	-	-	-	-	-	-	-
375	EU 60	98.30-98.20	-	1	28.3	Bison size	-	Long bone	-	Medial	-	-	-	-	1	-	-	-	spiral fractured, rodent chewed
375	EU 60	98.30-98.20	-	1	18.1	Bison size	-	Vertebra	immature	Medial	-	-	1	-	-	-	-	-	-
375	EU 60	98.30-98.20	-	1	0.4	Indeterminate	-	tooth	-	Frags	-	1	-	-	-	-	-	-	-
375	EU 60	98.30-98.20	-	17	9.0	Indeterminate	-	-	-	Frags	-	17	-	-	-	-	-	-	-
377	EU 61	98.40-98.30	-	2	7.2	Deer size	-	Long bone	-	Medial	-	-	2	-	-	-	-	-	spiral fractured
377	EU 61	98.40-98.30	-	7	4.4	Indeterminate	-	-	-	Frags	-	6	1	-	-	-	-	-	-
378	EU 61	98.30-98.20	-	1	1.1	Deer size	-	Malleolus lateral	-	Complete	-	1	-	-	-	-	-	-	-
378	EU 61	98.30-98.20	-	6	10.7	Deer size	-	Long bone	-	Medial	-	3	3	-	-	-	-	-	-
378	EU 61	98.30-98.20	-	8	3.6	Indeterminate	-	-	-	Frags	-	7	1	-	-	-	-	-	-
380	EU 62	98.50-98.40	-	1	3.4	Bison size	-	Long bone	-	Medial	-	1	-	-	-	-	-	-	-
381	EU 62	98.40-98.30	-	3	1.4	Indeterminate	-	-	-	Frags	-	3	-	-	-	-	3 black	-	-
381	EU 62	98.40-98.30	-	19	7.1	Indeterminate	-	-	-	Frags	-	19	-	-	-	-	-	-	-
381	EU 62	98.40-98.30	-	1	0.5	Deer size	-	Long bone	-	Medial	-	1	-	-	-	-	-	-	spiral fractured
382	EU 62	98.30-98.20	-	1	2.9	Deer size	-	Tibia	immature	Distal	R	1	-	-	-	-	-	-	-
382	EU 62	98.30-98.20	-	6	9.1	Deer size	-	Long bone	-	Medial	-	2	4	-	-	-	-	-	-
382	EU 62	98.30-98.20	-	8	5.2	Indeterminate	-	-	-	Frags	-	6	-	-	-	-	-	-	-
384	EU 63	98.10-98.00	-	5	3.3	Indeterminate	-	-	-	Frags	-	3	2	-	-	-	-	-	-
385	EU 63	98.00-97.90	-	1	2.4	Deer	-	Tooth, P3	young	Complete	R	1	-	-	-	-	-	-	-
385	EU 63	98.00-97.90	-	1	0.3	Indeterminate	-	-	-	Frags	-	1	-	-	-	-	black	-	-
385	EU 63	98.00-97.90	-	1	4.2	Bison size	-	Long bone	-	Medial	-	1	-	-	-	-	-	-	-
385	EU 63	98.00-97.90	-	2	2.7	Deer size	-	Long bone	-	Medial	-	1	1	-	-	-	-	-	-
385	EU 63	98.00-97.90	-	4	0.9	Indeterminate	-	-	-	Frags	-	4	-	-	-	-	-	-	-
385	EU 63	98.00-97.90	-	1	0.8	Fish	-	Skull	-	Frags	-	-	1	-	-	-	-	-	slightly rounded, water worn?
386	EU 63	97.90-97.80	-	1	0.1	Indeterminate	-	Long bone	fetal	Medial	-	1	-	-	-	-	-	-	-

Appendix A, continued

Lot #	Unit	Elevation	Feature	Qty	Wt (g)	Taxon	Species	Element	Age	Portion	Side	Size, 0-3 cm	Size, 3-6 cm	Size, 6-9 cm	Size, 9-12 cm	Size, >12 cm	Burned (Color)	Cut Marks (Type)	Comments
386	EU 63	97.90-97.80	-	8	3.6	Indeterminate	-	Long bone	-	Medial	-	8	-	-	-	-	-	-	-
387	EU 63	97.80-97.70	-	1	4.0	Bison size	-	Rib	-	Medial	-	-	1	-	-	-	-	-	-
388	EU 64	98.07-98.00	-	1	0.6	Indeterminate	-	-	-	Frags	-	1	-	-	-	-	-	-	-
389	EU 64	98.00-97.90	-	1	0.5	Deer size	-	Tooth	-	Frags	-	1	-	-	-	-	-	-	-
389	EU 64	98.00-97.90	-	2	2.0	Deer size	-	Long bone	-	Medial	-	1	1	-	-	-	-	-	-
389	EU 64	98.00-97.90	-	4	1.1	Indeterminate	-	-	-	Frags	-	4	-	-	-	-	-	-	-
390	EU 64	97.90-97.80	-	2	14.9	Bison size	-	Rib	-	Medial	-	-	-	2	-	-	-	-	rodent chewed
390	EU 64	97.90-97.80	-	1	1.4	Deer size	-	Rib	-	Medial	-	-	1	-	-	-	-	-	-
390	EU 64	97.90-97.80	-	1	0.6	Turtle	-	Carapace	-	Medial	-	1	-	-	-	-	-	-	-
390	EU 64	97.90-97.80	-	15	5.5	Indeterminate	-	-	-	Frags	-	13	2	-	-	-	-	1 with cuts	-
390	EU 64	97.90-97.80	-	1	0.2	Fish	-	Skull	-	-	-	1	-	-	-	-	-	-	-
391	EU 64	97.80-97.70	-	7	1.3	Indeterminate	-	-	-	Frags	-	7	-	-	-	-	-	-	-
393	EU 65	98.00-97.90	-	1	0.4	Deer size	-	Long bone	-	Medial	-	1	-	-	-	-	-	-	-
394	EU 65	97.90-97.80	-	1	8.4	Bison size	-	Tooth, maxillary	old	Complete	-	1	-	-	-	-	-	-	-
394	EU 65	97.90-97.80	-	1	0.7	Deer size	-	3rd Phalange	-	Complete	-	1	-	-	-	-	-	-	-
394	EU 65	97.90-97.80	-	1	4.1	Bison size	-	Long bone	-	Medial	-	-	1	-	-	-	-	-	-
394	EU 65	97.90-97.80	-	13	2.4	Indeterminate	-	-	-	Frags	-	13	-	-	-	-	-	-	-
396	EU 66	98.00-97.90	-	1	0.1	Indeterminate	-	-	-	Frags	-	1	-	-	-	-	-	-	-
397	EU 66	97.90-97.80	-	1	1.1	Bison size	-	Tooth	-	Frags	-	1	-	-	-	-	-	-	-
397	EU 66	97.90-97.80	-	3	7.0	Bison size	-	Rib	-	Medial	-	1	2	.	-	-	-	-	-
397	EU 66	97.90-97.80	-	1	1.8	Deer size	-	Rib	-	Medial	-	-	1	-	-	-	-	-	-
397	EU 66	97.90-97.80	-	6	1.2	Indeterminate	-	-	-	Frags	-	6	-	-	-	-	black	-	-
397	EU 66	97.90-97.80	-	14	4.3	Indeterminate	-	-	-	Frags	-	14	-	-	-	-	-	-	-
398	EU 66	97.80-97.70	-	8	1.3	Indeterminate	-	-	-	Frags	-	8	-	-	-	-	-	-	-
398	EU 66	97.80-97.70	-	7	8.3	Deer size	-	Scapula	-	Medial	-	5	2	-	-	-	-	-	-
399	EU 67	98.00-97.90	-	1	0.1	Indeterminate	-	-	-	Frags	-	1	-	-	-	-	-	-	-
400	EU 67	97.90-97.80	-	3	1.4	Indeterminate	-	-	-	Frags	-	2	1	-	-	-	1 black	-	-
400	EU 67	97.90-97.80	-	12	3.4	Indeterminate	-	-	-	Frags	-	12	-	-	-	-	2 black	-	-
401	EU 67	97.80-97.70	-	1	5.6	Bison size	-	Cuneiform	-	Medial	R	1	-	-	-	-	-	-	-
401	EU 67	97.80-97.70	-	3	1.7	Indeterminate	-	Rib	-	Frags	-	2	1	-	-	-	-	-	-
401-3	EU 67	97.80-97.70	-	1	1.1	Canid	-	Tooth	-	Complete	-	1	-	-	-	-	-	-	not modified
403	EU 68	97.90-97.80	-	4	1.3	Indeterminate	-	-	-	Frags	-	4	-	-	-	-	-	-	-
403	EU 68	97.90-97.80	-	1	0.5	Turtle	-	Carapace	-	Frags	-	1	-	-	-	-	-	-	-
404	EU 68	97.80-97.70	-	1	2.0	Deer	-	3rd Phalange	-	Complete	R	1	-	-	-	-	-	-	-
404	EU 68	97.80-97.70	-	2	0.8	Turtle	-	Carapace	-	Frags	-	2	-	-	-	-	-	-	-
404	EU 68	97.80-97.70	-	1	2.6	Bison size	-	Long bone	-	Frags	-	1	-	-	-	-	-	-	-
404	EU 68	97.80-97.70	-	6	2.4	Indeterminate	-	Rib	-	Frags	-	6	-	-	-	-	1 black	-	-
404	EU 68	97.80-97.70	-	1	0.1	Rodent	-	Long bone	-	Frags	-	1	-	-	-	-	-	-	-
405	EU 68	97.70-97.60	-	5	53.2	Bison size	-	Rib	-	Medial	-	1	2	1	-	1	-	-	weathered
406	EU 69	98.05-97.90	-	3	0.6	Indeterminate	-	-	-	Frags	-	3	-	-	-	-	-	-	-
407	EU 69	97.90-97.80	-	1	2.6	Deer size	-	Long bone	-	Medial	-	-	1	-	-	-	-	-	spiral fractured
407	EU 69	97.90-97.80	-	6	1.2	Indeterminate	-	-	-	Frags	-	6	-	-	-	-	-	-	-
408	EU 69	97.8-97.70	-	1	4.9	Bison size		Rib	-	Medial	-	-	1	-	-	-	-	-	-
408	EU 69	97.8-97.70	-	1	3.0	Deer size	-	Rib	-	Medial	-	-	1	-	-	-	-	-	edges round, rodent chewed?

Appendix A, continued

Lot #	Unit	Elevation	Feature	Qty	Wt (g)	Taxon	Species	Element	Age	Portion	Side	Size, 0-3 cm	Size, 3-6 cm	Size, 6-9 cm	Size, 9-12 cm	Size, >12 cm	Burned (Color)	Cut Marks (Type)	Comments
408	EU 69	97.8-97.70	-	13	6.0	Indeterminate	-	-	-	Frags	-	13	-	-	-	-	1 white	-	-
410	EU 70	98.0-97.90	-	18	7.4	Indeterminate	-	-	-	Frags	-	16	2	-	-	-	1 white, 1 black	-	-
410	EU 70	98.0-97.90	-	1	0.1	Rodent	-	Tooth	-	Frags	-	1	-	-	-	-	-	-	-
411	EU 70	97.90-97.80	-	2	6.9	Deer size	-	Long bone	-	Medial	-	-	2	-	-	-	-	-	spiral fractured
411	EU 70	97.90-97.80	-	2	3.6	Deer size	-	Rib	-	Medial	-	-	2	-	-	-	-	-	-
411	EU 70	97.90-97.80	-	14	4.0	Indeterminate	-	-	-	Frags	-	14	-	-	-	-	-	-	-
412	EU 70	97.80-97.70	-	1	0.7	Deer size	-	Long bone	-	Medial	-	1	-	-	-	-	-	-	-
412	EU 70	97.80-97.70	-	3	1.3	Rabbit	Jack	Femur	immature	Distal	R	3	-	-	-	-	-	-	-
413	EU 71	98.0-97.90	-	2	1.6	Indeterminate	-	-	-	Frags	-	2	-	-	-	-	-	-	-
414	EU 71	97.90-97.80	-	1	18.8	Bison size	-	Humerus	-	Proximal	R	-	1	-	-	-	-	-	rodent chewed
414	EU 71	97.90-97.80	-	1	0.8	Deer size	-	Rib	-	Medial	-	1	-	-	-	-	-	3-5 thin	-
414	EU 71	97.90-97.80	-	23	21.1	Indeterminate	-	Rib	-	Frags	-	21	2	-	-	-	-	-	-
414	EU 71	97.90-97.80	-	2	2.5	Indeterminate	-	-	-	Frags	-	2	-	-	-	-	-	-	-
415	EU 71	97.80-97.70	-	3	6.8	Deer size	-	Scapula	-	Proximal	L	1	2	-	-	-	-	-	-
415	EU 71	97.80-97.70	-	4	15.2	Bison size	-	Rib	-	Medial	-	3	1	-	-	-	-	-	-
415	EU 71	97.80-97.70	-	31	17.7	Indeterminate	-	Rib	-	Medial	-	30	1	-	-	-	-	-	-
416	EU 71	97.65	-	6	43.7	Bison size	-	Rib	-	Medial	-	1	-	1	1	3	-	3+ tiny	-
418	EU 72	97.90-97.80	-	9	4.3	Indeterminate	-	Long bone	-	Medial	-	9	-	-	-	-	-	-	-
421	EU 73	98.00-97.90	-	2	0.2	Indeterminate	-	Rib	-	Frags	-	2	-	-	-	-	white/black	-	-
422	EU 73	97.90-97.80	-	1	0.3	Deer size	-	Tooth, incisor	-	Complete	-	1	-	-	-	-	-	-	-
422	EU 73	97.90-97.80	-	1	0.4	Indeterminate	-	Tooth	-	Frags	-	1	-	-	-	-	-	-	-
422	EU 73	97.90-97.80	-	10	9.1	Indeterminate	-	Rib	-	Frags	-	9	1	-	-	-	1 black	-	-
423	EU 73	97.80-97.70	-	1	7.9	Deer size	-	Femur	-	Proximal	-	-	1	-	-	-	-	4 thin on neck	
423	EU 73	97.80-97.70	-	1	13.2	Deer size	-	Long bone	-	Frags	-	8	2	-	-	-	-	-	-
424	EU 73	97.70-97.60	-	3	43.9	Bison	-	Rib	-	Medial	-	-	-	-	-	2	-	lots thin	-
424	EU 73	97.70-97.60	-	1	2.5	Dog/Coyote	-	Scapula	-	Proximal	L	-	1	-	-	-	-	-	-
424	EU 73	97.70-97.60	-	2	7.9	Dog/Coyote	-	Femur	-	Proximal	R	-	-	1	-	-	-	-	-
424	EU 73	97.70-97.60	-	7	2.1	Indeterminate	-	-	-	Frags	-	7	-	-	-	-	-	-	-
426	EU 74	97.90-97.80	-	3	1.4	Fish	-	Vertebra	-	Frags	-	3	-	-	-	-	-	-	-
426	EU 74	97.90-97.80	-	13	4.0	Indeterminate	-	-	-	Frags	-	13	-	-	-	-	1 white	-	-
426	EU 74	97.90-97.80	-	1	0.1	Indeterminate	-	Long bone	fetal	Medial	-	1	-	-	-	-	-	-	-
427	EU 74	97.8-97.7	-	1	1.4	Deer	-	Tooth, molar	old	Complete	-	1	-	-	-	-	-	-	-
427	EU 74	97.8-97.7	-	1	5.1	Deer	-	Ulna	-	Proximal	R	-	1	-	-	-	-	-	weathered, root etched
427	EU 74	97.8-97.7	-	3	0.7	Fish	-	Vertebra	-	Frags	-	3	-	-	-	-	-	-	-
427	EU 74	97.8-97.7	-	2	0.3	Rabbit size	-	Long bone	-	Medial	-	2	-	-	-	-	-	-	-
427	EU 74	97.8-97.7	-	1	0.2	Rabbit	Cottontail	Calcanium	-	Complete	R	1	-	-	-	-	-	-	-
427	EU 74	97.8-97.7	-	59	16.8	Indeterminate	-	-	-	Frags	-	57	2	-	-	-	2 white 1 black	-	-
428	EU 75	98.10-98.00	-	1	4.8	Deer size	-	Patella	-	Complete	L	1	-	-	-	-	-	-	-
428	EU 75	98.10-98.00	-	2	7.7	Bison size	-	Long bone	-	Medial	-	2	-	-	-	-	-	-	-
428	EU 75	98.10-98.00	-	4	2.7	Indeterminate	-	Rib	-	Frags	-	4	-	-	-	-	-	-	-
429	EU 75	98.10-98.00	-	1	6.0	Bison size	-	Long bone	-	Medial	-	-	1	-	-	-	-	-	-
429	EU 75	98.10-98.00	-	1	0.1	Fish	-	Skull	-	Frags	-	1	-	-	-	-	-	-	-
429	EU 75	98.10-98.00	-	12	5.8	Indeterminate	-	-	-	Frags	-	10	2	-	-	-	-	-	-

Appendix A, continued

Lot #	Unit	Elevation	Feature	Qty	Wt (g)	Taxon	Species	Element	Age	Portion	Side	Size, 0-3 cm	Size, 3-6 cm	Size, 6-9 cm	Size, 9-12 cm	Size, >12 cm	Burned (Color)	Cut Marks (Type)	Comments
430	EU 75	97.90-97.80	-	1	34.8	Bison size	-	Rib	-	Medial	-	-	-	-	-	1	-	2 tiny	weathered surface, rodent chewed
430	EU 75	97.90-97.80	-	3	29.4	Bison size	-	Long bone	-	Frags	-	-	2	1	-	-	-	-	-
430	EU 75	97.90-97.80	-	5	4.4	Turtle	Cooter	Carapace	-	Frags	-	3	1	-	-	-	-	-	-
430	EU 75	97.90-97.80	-	28	18.1	Indeterminate	-	-	-	Frags	-	28	-	-	-	-	1 white	-	-
431	EU 75	97.80-97.70	-	1	22.6	Bison size	-	Long bone	-	Frags	-	-	-	1	-	-	-	-	-
433	EU 76	98.00-97.90	-	1	2.4	Bison size	-	Rib	-	Medial	-	-	1	-	-	-	-	-	-
433	EU 76	98.00-97.90	-	7	6.3	Indeterminate	-	-	-	Frags	-	6	1	-	-	-	-	-	-
434	EU 76	97.90-97.80	-	3	16.9	Bison size	-	Rib	-	Medial	-	-	1	2	-	-	-	-	-
434	EU 76	97.90-97.80	-	25	13.8	Indeterminate	-	Rib/long bone	-	Medial	-	23	2	-	-	-	-	-	-
434	EU 76	97.90-97.80	-	1	0.1	Fish	-	Vertebra	-	Medial	-	1	-	-	-	-	-	-	-
435	EU 76	97.80-97.70	-	1	3.3	Deer size	-	2nd Phalange	-	Complete	-	1	-	-	-	-	-	-	-
435	EU 76	97.80-97.70	-	1	12.5	Deer size	-	Metatarsal	-	Medial	-	-	-	-	-	1	-	-	rodent chewed, weathered
437	EU 77	98.47-98.30	-	1	0.1	Indeterminate	-	Long bone	-	Frags	-	1	-	-	-	-	-	-	-
438	EU 77	98.30-98.20	-	2	12.5	Bison size	-	Ribs	-	Medial	-	-	1	1	-	-	-	-	root etched, minor rodent chewed
438	EU 77	98.30-98.20	-	10	3.0	Indeterminate	-	Ribs	-	Frags	-	10	-	-	-	-	-	-	-
439	EU 77	98.20-98.10	-	2	0.8	Indeterminate	-	Ribs	-	Frags	-	2	-	-	-	-	-	-	-
439	EU 77	98.20-98.10	-	1	0.1	Bird	-	Coracoid	-	Proximal	L	1	-	-	-	-	-	-	smaller than duck
440	EU 77	98.10-98.00	-	1	0.1	Indeterminate	i	-	-	Frags	-	1	-	-	-	-	-	-	-
442	EU 78	98.40-98.30	-	5	2.8	Indeterminate	-	-	-	Frags	-	5	-	-	-	-	-	-	-
442	EU 78	98.40-98.30	-	1	1.5	Bison size	-	Long bone	fetal	Medial	-	1	-	-	-	-	-	-	possible new born, layers solidifying
443	EU 78	98.30-98.20	-	1	0.1	Indeterminate	-	-	-	Frags	-	1	-	-	-	-	-	-	-
444	EU 79	98.54-98.40	-	1	1.5	Indeterminate	-	-	-	Frags	-	2	-	-	-	-	-	-	-
445	EU 79	98.40-98.30	-	1	5.3	Bison size	-	Rib	-	Medial	-	-	1	-	-	-	-	-	weathered, rounded
445	EU 79	98.40-98.30	-	1	0.3	Fish	-	Otolith	-	Medial 1/2	-	1	-	-	-	-	white	-	-
445	EU 79	98.40-98.30	-	1	3.4	Deer size	-	Metapodial	-	Medial	-	1	-	-	-	-	-	-	spiral Fractured
445	EU 79	98.40-98.30	-	12	8.6	Indeterminate	-	-	-	Frags	-	12	-	-	-	-	-	-	-
446	EU 79	98.30-98.20	-	1	6.9	Deer size	-	Long bone	-	Medial	-	-	1	-	-	-	-	-	spiral fractured
447	EU 80	98.50-98.40	-	4	4.0	Indeterminate	-	-	-	Frags	-	3	1	-	-	-	-	-	-
447	EU 80	98.50-98.40	-	1	0.4	Deer size	-	Sesimoid	-	Complete	-	1	-	-	-	-	-	-	weathered
448	EU 80	98.40-98.30	-	1	6.1	Bison size	-	Rib	-	Medial	-	-	1	-	-	-	-	-	-
448	EU 80	98.40-98.30	-	5	4.7	Indeterminate	-	-	-	Frags	-	4	1	-	-	-	-	-	-
450	EU 81	98.42-98.30	-	1	0.3	Indeterminate	-	-	-	Frags	-	1	-	-	-	-	-	-	-
451	EU 81	98.30-98.20	-	3	51.7	Bison size	-	Femur	Mature	Distal	L	1	1	1	-	-	-	-	-
451	EU 81	98.30-98.20	-	1	8.2	Bison size	-	Rib	-	Medial	-	-	-	1	-	-	-	-	-
451	EU 81	98.30-98.20	-	16	10.3	Indeterminate	-	-	-	Frags	-	13	3	-	-	-	-	-	-
452	EU 81	98.20-98.10	-	1	77.3	Bison	-	Femur	Mature	Distal	L	-	-	1	-	-	-	-	rodent chewed
452	EU 81	98.20-98.10	-	2	0.4	Indeterminate	-	-	-	Frags	-	2	-	-	-	-	-	-	-
454	EU 82	98.46-98.30	-	1	0.5	Indeterminate	-	Rib	-	Frags	-	1	-	-	-	-	-	-	-

Appendix A, continued

Lot #	Unit	Elevation	Feature	Qty	Wt (g)	Taxon	Species	Element	Age	Portion	Side	Size, 0-3 cm	Size, 3-6 cm	Size, 6-9 cm	Size, 9-12 cm	Size, >12 cm	Burned (Color)	Cut Marks (Type)	Comments
454	EU 82	98.46-98.30	-	1	0.6	Rabbit size	-	Long bone	-	Medial	-	-	1	-	-	-	-	-	-
455	EU 82	98.30-98.20	-	5	6.3	Indeterminate	-	-	-	Frags	-	4	1	-	-	-	-	-	-
456	EU 82	98.20-98.10	-	1	5.4	Bison size	-	Rib	-	Medial	-	-	-	1	-	-	-	-	-
456	EU 82	98.20-98.10	-	5	4.3	Indeterminate	-	-	-	Frags	-	5	-	-	-	-	-	-	-
457	EU 83	97.97-97.90	-	2	1.4	Indeterminate	-	-	-	Frags	-	2	-	-	-	-	-	-	-
458	EU 83	97.90-97.80	-	1	2.2	Deer size	-	Rib	-	Medial	-	-	1	-	-	-	-	-	-
458	EU 83	97.90-97.80	-	1	4.2	Deer size	-	Metapodial	-	Proximal	-	-	1	-	-	-	-	-	-
458	EU 83	97.90-97.80	-	2	1.4	Turtle	-	Carapace	-	Medial	-	2	-	-	-	-	-	-	-
458	EU 83	97.90-97.80	-	15	5.4	Indeterminate	-	-	-	Frags	-	15	-	-	-	-	-	1 with thin	-
459	EU 83	97.80-97.70	-	32	8.4	Indeterminate	-	-	-	Frags	-	32	-	-	-	-	1 black	-	-
459	EU 83	97.80-97.70	-	3	1.5	Turtle	-	Carapace	-	Medial	-	3	-	-	-	-	-	-	-
459	EU 83	97.80-97.70	-	3	1.6	Fish	-	Vertebra	-	Medial	-	3	-	-	-	-	-	-	-
459	EU 83	97.80-97.70	-	4	0.9	Fish	-	Skull	-	Frags	-	4	-	-	-	-	-	-	1 large, 2 med
460	EU 83	98.76	-	1	9.0	Bison size	-	Rib	-	Medial	-	-	-	-	1	-	-	3-4 thin	root etched
461	EU 83	98.73	-	1	52.3	Bison size	-	Metacarpal	Newborn	Medial	L	-	-	-	1	-	-	-	complete except ends, just fused sides
463	EU 84	98.06-97.90	-	5	4.7	Indeterminate	-	-	-	Frags	-	5	-	-	-	-	1 black	-	-
464	EU 84	97.90-97.80	-	4	30.3	Bison size	-	Ribs	-	Medial	-	-	-	2	2	-	-	-	1 rodent chewed
464	EU 84	97.90-97.80	-	4	0.8	Indeterminate	-	-	-	Frags	-	4	-	-	-	-	-	-	-
464	EU 84	97.90-97.80	-	1	0.5	Canid	-	Tooth	-	Complete	-	1	-	-	-	-	-	-	-
465	EU 84	97.80-97.7	-	1	14.2	Bison size	-	Rib	-	Medial	-	-	-	-	1	-	-	-	rodent chewed
465	EU 84	97.80-97.7	-	1	0.7	Rabbit size	-	Long bone	-	Medial	-	-	1	-	-	-	-	-	-
465	EU 84	97.80-97.7	-	1	2.2	Fish	-	Vertebra	-	Complete	-	1	-	-	-	-	-	-	large
465	EU 84	97.80-97.7	-	1	0.3	Fish	-	Skull	-	Frags	-	1	-	-	-	-	-	-	-
465	EU 84	97.80-97.7	-	28	24.9	Indeterminate	-	Rib	-	Frags	-	23	4	1	-	-	-	-	-
465	EU 84	97.80-97.7	-	2	7.6	Indeterminate	-	-	-	Frags	-	2	-	-	-	-	-	-	-
465	EU 84	97.80-97.70	-	58	476.2	Bison	-	Scapula	-	Proximal	R	38	6	10	3	1	-	-	rodent chewed
465	EU 84	97.80-97.70	-	1	68.3	Bison size	-	Rib	-	Medial	-	-	-	-	-	1	-	-	rodent chewed
467	EU 85	98.00-97.90	-	3	1.1	Indeterminate	-	-	-	Frags	-	3	-	-	-	-	-	-	-
468	EU 85	97.90-97.80	-	3	1.2	Indeterminate	-	Rib	-	Frags	-	3	-	-	-	-	-	-	-
469	EU 85	97.80-97.70	-	5	50.0	Bison size	-	Rib	-	Medial	-	-	1	3	-	1	-	lots	-
469	EU 85	97.80-97.70	-	1	0.8	Deer	-	3rd Phalange	-	Complete	-	1	-	-	-	-	-	-	-
469	EU 85	97.80-97.70	-	3	1.3	Fish	-	Skull	-	Frags	-	3	-	-	-	-	-	-	-
469	EU 85	97.80-97.70	-	38	19.8	Indeterminate	-	-	-	Frags	-	31	7	-	-	-	-	-	-
469-1	EU 85	97.80-97.70	-	2	2.7	Deer	-	Antler	-	Frags	-	2	-	-	-	-	white	-	-
471	EU 86	98.10-98.00	-	1	2.8	Indeterminate	-	Long bone	-	Medial	-	1	-	-	-	-	-	-	rodent chewed
472	EU 86	97.90-97.80	-	15	20.9	Indeterminate	-	-	-	Frags	-	12	3	-	-	-	-	-	1 rounded edges, water transport
473	EU 86	97.90-97.80	-	1	28.9	Bison	-	Scaphoid	-	Complete	L	-	1	-	-	-	-	-	rodent chewed
473	EU 86	97.90-97.80	-	1	22.3	Deer size	-	Humerus	-	Distal	L	-	1	-	-	-	-	-	butchered
473	EU 86	97.90-97.80	-	3	20.6	Deer size	-	Long bone	-	Medial	-	-	2	1	-	-	-	-	-
473	EU 86	97.90-97.80	-	1	6.8	Bison size	-	Long bone	-	Frags	-	-	1	-	-	-	-	-	-
473	EU 86	97.90-97.80	-	28	15.2	Indeterminate	-	-	-	Frags	-	28	-	-	-	-	1 white	-	-

Appendix A, continued

Lot #	Unit	Elevation	Feature	Qty	Wt (g)	Taxon	Species	Element	Age	Portion	Side	Size, 0-3 cm	Size, 3-6 cm	Size, 6-9 cm	Size, 9-12 cm	Size, >12 cm	Burned (Color)	Cut Marks (Type)	Comments
474	EU 86	97.80-97.70	-	2	8.1	Deer size	-	Long bone	-	Medial	-	-	2	-	-	-	-	-	-
474	EU 86	97.80-97.70	-	4	1.1	Indeterminate	-	-	-	Frags	-	4	-	-	-	-	-	-	-
475	EU 87	98.02-97.90	-	2	0.8	Indeterminate	-	-	-	Frags	-	2	-	-	-	-	-	-	-
476	EU 87	97.90-97.80	-	19	11.4	Indeterminate	-	-	-	Frags	-	18	1	-	-	-	-	-	-
477	EU 87	97.80-97.70	-	1	0.3	Deer size	-	Tooth	deciduous	Frags	-	1	-	-	-	-	-	-	-
477	EU 87	97.80-97.70	-	1	0.3	Rabbit size	-	Long bone	-	Frags	-	1	-	-	-	-	-	-	-
477	EU 87	97.80-97.70	-	49	34.6	Indeterminate	-	-	-	Frags	-	44	5	-	-	-	5 black	-	-
478	EU 87	97.75-97.70	-	1	25.5	Deer	-	Maxilla	Mature	Tooth row	R	-	-	-	1	-	-	-	intact + frags PM 2, 3, M1,M2, M3
479	EU 87	97.70-97.60	-	1	33.0	Deer	-	Scapula	-	Complete	L	-	-	-	-	1	-	-	-
479	EU 87	97.70-97.60	-	37	9.6	Indeterminate	-	-	-	Frags	-	32	5	-	-	-	-	-	-
479	EU 87	97.70-97.60	-	3	0.7	Fish	-	Skull	-	Frags	-	3	-	-	-	-	-	-	-
479	EU 87	97.70-97.60	-	1	1.8	Fish	-	Vertebra	-	Complete	-	1	-	-	-	-	-	-	large
480	EU 88	98.02-97.90	-	1	4.0	Deer size	-	Metapodial	-	Medial	-	-	1	-	-	-	-	-	rodent chewed
481	EU 88	97.90-97.80	-	1	8.5	Deer size	-	Pelvis, acetabula	-	Medial	R	-	1	-	-	-	-	multiple	-
481	EU 88	97.90-97.80	-	1	3.7	Pronghorn	-	Tooth, M1	-	Complete	R	1	-	-	-	-	-	-	mostly present
481	EU 88	97.90-97.80	-	2	1.3	Turtle	-	Carapace	-	Medial	-	2	-	-	-	-	2 brown	-	-
481	EU 88	97.90-97.80	-	19	8.4	Indeterminate	-	-	-	Frags	-	15	4	-	-	-	-	-	-
481	EU 88	97.90-97.80	-	5	5.7	Carnivor	-	Mandible	very young	Medial	L	-	-	1	-	-	-	-	2 teeth, rodent chewed
482	EU 88	97.80-97.70	-	1	4.3	Deer size	-	Long bone	-	Medial	-	1	-	-	-	-	-	-	-
482	EU 88	97.80-97.70	-	54	19.2	Indeterminate	-	-	-	Frags	-	51	3	-	-	-	1 white, 2 gray, 6 black	-	-
483	EU 88	97.75-97.71	-	6	55.3	Bison size	-	Rib	-	Medial	-	2	-	1	1	2	-	5-8 thin	rodent chewed
484	EU 88	97.68-97.62	-	10	62.2	Bison size	-	Rib	-	Proximal	-	7	1	1	-	1	-	13 tiny	1 shallow impact scar
485	EU 88	97.70-97.6	-	1	11.1	Deer size	-	Long bone	-	Medial	-	-	-	1	-	-	-	-	spiral fractured
485	EU 88	97.70-97.6	-	1	4.5	Bison size	-	Tibia	-	Distal	-	-	1	-	-	-	-	-	frag
485	EU 88	97.70-97.6	-	12	10.1	Indeterminate	-	-	-	Frags	-	12	-	-	-	-	-	-	-
486	EU 89	97.87-97.80	-	10	10.4	Indeterminate	-	-	-	Frags	-	8	2	-	-	-	-	-	-
487	EU 89	97.80-97.70	-	1	1.2	Deer size	-	Cuneiform pes	-	Lateral	R	1	-	-	-	-	-	-	-
487	EU 89	97.80-97.70	-	4	3.0	Indeterminate	-	-	-	Frags	-	2	1	-	-	-	-	-	-
487	EU 89	97.80-97.70	-	1	0.6	Turtle	-	Carapace	-	Frags	-	1	-	-	-	-	-	-	-
488	EU 89	97.70-97.60	-	2	1.1	Turtle	-	Carapace	-	Frags	-	2	-	-	-	-	2 black	-	-
488	EU 89	97.70-97.60	-	2	4.2	Deer size	-	Radius	-	Proximal	R	2	-	-	-	-	-	-	-
488	EU 89	97.70-97.60	-	33	19.4	Indeterminate	-	-	-	Frags	-	31	-	2	-	-	-	-	-
488	EU 89	97.70-97.60	-	1	0.3	Fish	-	Skull	-	Frags	-	1	-	-	-	-	-	-	-
489	EU 89	97.69	-	12	21.4	Bison size	-	Rib	-	medial	-	8	2	1	-	1	-	-	-
490	EU 90	97.86-97.80	-	5	2.1	Indeterminate	-	-	-	Frags	-	5	-	-	-	-	-	-	-
491	EU 90	97.80-97.7	-	5	5.0	Indeterminate	-	-	-	Frags	-	5	-	-	-	-	-	-	-
492	EU 90	97.70-97.60	-	1	16.2	Bison	-	1st Phalange	-	Distal	-	-	1	-	-	-	-	tiny cuts	rodent chewed
492	EU 90	97.70-97.60	-	1	5.0	Deer size	-	Rib	-	Medial	-	-	1	-	-	-	-	-	-
492	EU 90	97.70-97.60	-	34	6.5	Indeterminate	-	-	-	Frags	-	34	-	-	-	-	1 white, 1 black	-	-
492	EU 90	97.70-97.60	-	2	0.3	Turtle	-	Carapace	-	Frags	-	2	-	-	-	-	-	-	-

Appendix A, continued

Lot #	Unit	Elevation	Feature	Qty	Wt (g)	Taxon	Species	Element	Age	Portion	Side	Size, 0-3 cm	Size, 3-6 cm	Size, 6-9 cm	Size, 9-12 cm	Size, >12 cm	Burned (Color)	Cut Marks (Type)	Comments
493	EU 90	97.65	-	1	110.4	Bison size	-	Radius	-	Medial	-	-	-	-	-	1	-	-	rodent chewed, spiral fractured
494	EU 91	97.80-97.70	-	26	10.5	Indeterminate	-	-	-	Frags	-	25	1	-	-	-	-	-	-
494	EU 91	97.80-97.70	-	1	0.2	Turtle	-	Carapace	-	Frags	-	1	-	-	-	-	-	-	-
495	EU 91	97.70-97.60	-	1	6.3	Indeterminate	-	Long bone	-	Medial		-	1	-	-	-	-	-	rounded edges, water worn?
495	EU 91	97.70-97.60	-	4	2.2	Indeterminate	-	Rib	-	-	-	4	-	-	-	-	-	-	-
495	EU 91	97.70-97.60	-	1	0.6	Squirrel	Gray squirrel	Femur	-	Proximal	L	-	1	-	-	-	-	-	dry bone break
496	EU 91	98.60-98.50	-	3	0.8	Indeterminate	-	Rib	-	Frags	-	3	-	-	-	-	-	-	-
498	EU 92	97.84-97.70	-	20	7.9	Indeterminate	-	-	-	Frags	-	20	-	-	-	-	-	-	-
498	EU 92	97.84-97.70	-	1	0.2	Turtle	-	Carapace	-	Frags	-	1	-	-	-	-	1 black	-	-
499	EU 92	97.70-97.60	-	1	7.3	Bison size	-	Rib	-	Medial	-	-	-	1	-	-	-	-	rounded edges, water worn?
499	EU 92	97.70-97.60	-	1	5.4	Deer size	-	Long bone	-	Medial	-	-	1	-	-	-	-	-	-
499	EU 92	97.70-97.60	-	4	2.7	Turtle	-	Carapace	-	Frags	-	4	-	-	-	-	-	-	-
499	EU 92	97.70-97.60	-	13	16.3	Indeterminate	-	-	-	Frags	-	12	1	-	-	-	-	-	-
500	EU 92	97.60-97.50	-	10	3.1	Indeterminate	-	-	-	Frags	-	10	-	-	-	-	4 white	-	-
500	EU 92	97.60-97.50	-	1	0.2	Turtle	-	Carapace	-	Frags	-	1	-	-	-	-	-	-	-
500	EU 92	97.60-97.50	-	1	3.8	Deer size	-	Long bone	-	Medial	-	-	1	-	-	-	-	-	spiral fractured
500	EU 92	97.60-97.50	-	2	2.8	Bison size	-	Long bone	Newborn	Medial	-	2	-	-	-	-	-	-	-
501	EU 93	97.86-97.70	-	17	14.3	Indeterminate	-	Rib	-	Frags	-	16	1	-	-	-	-	-	-
501	EU 93	97.86-97.70	-	1	0.3	Turtle	-	Carapace	-	Frags	-	1	-	-	-	-	-	-	-
502	EU 93	97.70-97.60	-	1	21.5	Bison size	-	Long bone	-	Medial	-	-	-	1	-	-	-	-	-
502	EU 93	97.70-97.60	-	1	8.1	Bison size	-	Tibia	immature	Distal	-	-	1	-	-	-	-	-	-
502	EU 93	97.70-97.60	-	1	0.5	Deer size	-	Tooth	-	Frags	-	1	-	-	-	-	-	-	-
502	EU 93	97.70-97.60	-	3	1.0	Turtle	-	Carapace	-	Frags	-	3	-	-	-	-	-	-	-
502	EU 93	97.70-97.60	-	30	11.3	Indeterminate	-	-	-	Frags	-	30	-	-	-	-	-	-	-
503	EU 93	97.60-97.50	-	1	1.6	Deer	-	Tooth, PM2	-	Complete	-	1	-	-	-	-	-	-	-
503	EU 93	97.60-97.50	-	4	10.4	Deer size	-	Long bone	-	Medial	-	1	2	1	-	-	-	-	-
503	EU 93	97.60-97.50	-	1	0.2	Squirrel	Gray squirrel	Humerus	-	Distal	-	1	-	-	-	-	-	-	dry bone break
503	EU 93	97.60-97.50	-	1	0.1	Rodent	-	Long bone	-	Medial	-	1	-	-	-	-	-	-	-
504	EU 94	97.95-97.80	-	4	0.9	Indeterminate	-	-	-	Frags	-	4	-	-	-	-	-	-	-
505	EU 94	97.80-97.70	-	13	26.5	Deer size	-	Long bone	-	Medial	-	10	3	-	-	-	-	-	-
505	EU 94	97.80-97.70	-	1	6.0	Bison size	-	Long bone	-	Medial	-	-	1	-	-	-	-	-	-
505	EU 94	97.80-97.70	-	1	0.4	Turtle	-	Carapace	-	Medial	-	1	-	-	-	-	-	-	-
506	EU 94	97.70-97.60	-	1	8.1	Deer	-	Tooth, maxillary, M2, M3	very young	Complete	-	1	-	-	-	-	-	-	-
506	EU 94	97.70-97.60	-	1	2.4	Deer	-	Mandible, tooth M2	med	Complete	-	1	-	-	-	-	-	-	-
506	EU 94	97.70-97.60	-	1	0.5	Indeterminate	-	Long bone	-	Medial	-	-	1	-	-	-	-	-	-
506	EU 94	97.70-97.60	-	1	0.1	Indeterminate	-	Ulna	-	Medial	-	1	-	-	-	-	-	-	-
506	EU 94	97.70-97.60	-	1	0.2	Indeterminate	-	Skull	-	Medial	-	1	-	-	-	-	-	-	-
506	EU 94	97.70-97.60	-	2	0.1	Indeterminate	-	Tooth, incisor	-	Complete	-	2	-	-	-	-	-	-	-

Appendix A, continued

Lot #	Unit	Elevation	Feature	Qty	Wt (g)	Taxon	Species	Element	Age	Portion	Side	Size, 0-3 cm	Size, 3-6 cm	Size, 6-9 cm	Size, 9-12 cm	Size, >12 cm	Burned (Color)	Cut Marks (Type)	Comments
506	EU 94	97.70-97.60	-	44	30.1	Indeterminate	-	-	-	Frags	-	41	3	-	-	-	2 white, 2 black	-	-
508	EU 95	98.00-97.90	-	6	1.5	Indeterminate	-	Rib	-	Frags	-	6	-	-	-	-	-	-	-
509	EU 95	97.90-97.80	-	4	11.0	Bison size	-	Rib	-	Frags	-	2	2	-	-	-	-	-	-
509	EU 95	97.90-97.80	-	12	7.4	Indeterminate	-	-	-	Frags	-	12	-	-	-	-	1 white	-	-
509	EU 95	97.90-97.80	-	2	1.1	Turtle	-	Carapace	-	Frags	-	2	-	-	-	-	-	-	-
509-1	EU 95	97.90-97.80	-	1	3.9	Indeterminate	-	-	-	Medial	-	-	-	1	-	-	-	-	awl like
510	EU 95	97.80-97.70	-	1	23.8	Bison size	-	Long bone	-	Medial	-	-	1	-	-	-	-	5 thin	-
510	EU 95	97.80-97.70	-	3	2.9	Bison size	-	Vertebra, cap	unfused	Distal	-	3	-	-	-	-	-	-	-
510	EU 95	97.80-97.70	-	13	6.6	Indeterminate	-	-	-	Frags	-	12	1	-	-	-	1 black	-	-
510	EU 95	97.80-97.70	-	3	4.0	Fish	-	Skull	-	Frags	-	3	-	-	-	-	-	-	-
511	EU 95	97.70-97.60	-	3	30.4	Bison size	-	Rib	-	Medial	-	-	-	-	1	-	-	6 thin	-
511	EU 95	97.70-97.60	-	1	0.3	Deer size	-	Tooth	-	Frags	-	1	-	-	-	-	-	-	-
511	EU 95	97.70-97.60	-	8	5.0	Indeterminate	-	-	-	Frags	-	7	1	-	-	-	-	-	-
512	EU 96	97.84-97.70	-	2	5.2	Bison size	-	Rib	-	Medial	-	-	1	1	-	-	-	-	-
512	EU 96	97.84-97.70	-	1	0.1	Bison size	-	Rib	-	Medial	-	1	-	-	-	-	-	-	-
512	EU 96	97.84-97.70	-	39	13.1	Indeterminate	-	-	-	Frags	-	39	-	-	-	-	3 black	-	-
512	EU 96	97.84-97.70	-	1	1.5	Deer size	-	Rib	-	Proximal	-	1	-	-	-	-	-	-	-
513	EU 96	97.70-97.60	-	1	0.4	Rabbit size	-	Long bone	-	Medial	-	1	-	-	-	-	-	-	-
513	EU 96	97.70-97.60	-	1	0.1	Turtle	-	Carapace	-	Medial	-	1	-	-	-	-	-	-	-
513	EU 96	97.70-97.60	-	6	2.7	Indeterminate	-	-	-	Frags	-	5	1	-	-	-	-	-	-
514	EU 96	97.60-97.50	-	1	1.0	Deer	-	3rd Phalange	-	Proximal	-	1	-	-	-	-	-	-	-
514	EU 96	97.60-97.50	-	1	8.4	Deer	-	Tooth, maxillary, M2, M3	very young	Complete	L		1	-	-	-	-	-	barely in wear
514	EU 96	97.60-97.50	-	7	3.4	Deer	-	Tooth, mandibular	-	Complete	L	7	-	-	-	-	-	-	deciduous erupting, age?
514	EU 96	97.60-97.50	-	1	2.2	Deer	-	Calcanium	unfused	Distal	R	1	-	-	-	-	-	-	-
514	EU 96	97.60-97.50	-	26	5.7	Indeterminate	-	Skull	-	Frags	-	26	-	-	-	-	-	-	-
515	EU 97	97.80-97.70	-	1	130.1	Bison	-	Radius	-	Proximal	R	-	-	-	1	-	-	-	-
515	EU 97	97.80-97.70	-	2	1.0	Deer	-	-	-	Frags	-	2	-	-	-	-	-	-	-
515	EU 97	97.80-97.70	-	20	15.7	Indeterminate	-	-	-	Frags	-	18	2	-	-	-	-	-	-
516	EU 97	97.70-97.60	-	1	270.1	Bison	-	Femur	Mature	Distal	R	-	-	-	-	1	-	22+ tiny	-
516	EU 97	97.70-97.60	-	2	52.0	Bison size	-	Rib	-	Medial	-	-	-	-	-	2	-	16+ tiny	-
516	EU 97	97.70-97.60	-	4	9.4	Bison size	-	Rib	-	Medial	-	-	3	1	-	-	-	-	-
516	EU 97	97.70-97.60	-	1	1.2	Deer size	-	Tooth	-	Frags	-	1	-	-	-	-	-	-	-
516	EU 97	97.70-97.60	-	1	0.2	Rodent	-	Mandible	-	Complete	R	1	-	-	-	-	-	-	-
516	EU 97	97.70-97.60	-	6	4.4	Fish	Catfish	Skull	-	Frags	-	5	1	-	-	-	-	-	-
516	EU 97	97.70-97.60	-	1	0.5	Fish	-	Vertebra	-	Complete	-	1	-	-	-	-	-	-	-
516	EU 97	97.70-97.60	-	50	14.2	Indeterminate	-	-	-	Frags	-	48	2	-	-	-	11 black, 1 white	-	-
517	EU 97	97.60-97.50	-	1	5.3	Deer	-	2nd Phalange	-	Complete	-	-	1	-	-	-	-	-	-
517	EU 97	97.60-97.50	-	7	9.0	Deer	-	Tooth, maxillary, M2, M3	-	Complete	R	-	1	-	-	-	-	-	check age, M3 barely worn
517	EU 97	97.60-97.50	-	12	5.2	Deer	-	Skull	-	Frags	-	12	-	-	-	-	-	-	-
517	EU 97	97.60-97.50	-	1	1.8	Bison size	-	Rib	-	Medial	-	1	-	-	-	-	-	-	-
518	EU 98	97.91-97.80	-	7	4.1	Indeterminate	-	-	-	Frags	-	7	-	-	-	-	-	-	-

Appendix A, continued

Lot #	Unit	Elevation	Feature	Qty	Wt (g)	Taxon	Species	Element	Age	Portion	Side	Size, 0-3 cm	Size, 3-6 cm	Size, 6-9 cm	Size, 9-12 cm	Size, >12 cm	Burned (Color)	Cut Marks (Type)	Comments
519	EU 98	97.8-97.70	-	2	39.5	Bison	-	1st Phalange	-	Complete	-	-	2	-	-	-	-	-	-
519	EU 98	97.8-97.70	-	1	8.8	Deer size	-	Long bone	-	Medial	-	-	1	-	-	-	-	-	rodent chewed
519	EU 98	97.8-97.70	-	1	9.8	Bison size	-	Rib	-	Medial	-	-	-	1	-	-	-	-	-
519	EU 98	97.8-97.70	-	25	10.3	Indeterminate	-	-	-	Frags	-	24	1	-	-	-	-	-	-
520	EU 98	97.70-97.60	-	2	2.3	Fish	-	Vertebra	-	Medial	-	2	-	-	-	-	-	-	looks like catfish
520	EU 98	97.70-97.60	-	18	6.5	Indeterminate	-	Rib	-	Frags	-	18	-	-	-	-	3 black	-	-
521	EU 98	97.60-97.50	-	1	0.4	Fish	-	Vertebra	-	Complete	-	1	-	-	-	-	-	-	-
521	EU 98	97.60-97.50	-	2	0.2	Indeterminate	-	-	-	Frags	-	2	-	-	-	-	-	-	-
523	EU 99	97.85-97.70	-	1	1.1	Deer	-	Tooth, PM3	-	Complete	-	1	-	-	-	-	-	-	light wear
523	EU 99	97.85-97.70	-	1	7.6	Bison size	-	Long bone	-	Medial	-	-	1	-	-	-	-	-	-
523	EU 99	97.85-97.70	-	1	0.2	Rabbit size	-	Ulna	-	Medial	-	1	-	-	-	-	-	-	-
523	EU 99	97.85-97.70	-	1	0.5	Turtle	-	Plastron	-	Medial	-	1	-	-	-	-	-	-	-
523	EU 99	97.85-97.70	-	10	5.2	Indeterminate	-	-	-	Frags	-	9	-	1	-	-	-	-	-
524	EU 99	97.70-97.60	-	16	5.5	Indeterminate	-	-	-	Frags	-	15	1	-	-	-	-	-	-
525	EU 99	97.60-97.50	-	1	1.4	Deer size	-	Long bone	-	Medial	-	-	1	-	-	-	-	-	-
526	EU 100	97.83-97.70	-	7	7.8	Indeterminate	-	Long bone	-	Medial	-	5	2	-	-	-	-	-	-
527	EU 100	97.70-97.60	-	1	1.4	Deer	-	Tooth, PM2	-	Complete	-	1	-	-	-	-	-	-	light wear
527	EU 100	97.70-97.60	-	1	3.8	Bison size	-	Rib	-	Medial	-	-	1	-	-	-	-	-	-
527	EU 100	97.70-97.60	-	7	4.3	Indeterminate	-	-	-	Frags	-	7	-	-	-	-	-	-	-
528	EU 100	97.60-97.50	-	3	5.1	Deer size	-	-	-	Medial	-	2	1	-	-	-	-	-	-
529	EU 101	97.80-97.70	-	2	1.9	Indeterminate	-	-	-	Medial	-	2	-	-	-	-	-	-	-
530	EU 101	97.70-97.60	-	1	1.3	Fish	-	Vertebra	-	Complete	-	1	-	-	-	-	-	-	large
530	EU 101	97.70-97.60	-	2	5.3	Bison size	-	Rib	-	Frags	-	-	2	-	-	-	-	-	-
530	EU 101	97.70-97.60	-	23	27.0	Indeterminate	-	-	-	Frags	-	20	3	-	-	-	-	-	-
531	EU 102	98.01-97.90	-	6	2.9	Indeterminate	-	-	-	Frags	-	6	-	-	-	-	-	-	-
532	EU 102	97.90-97.80	-	1	1.1	Deer	-	Tooth, M2	-	Complete	R	2	-	-	-	-	-	-	-
532	EU 102	97.90-97.80	-	8	6.5	Indeterminate	-	-	-	Frags	-	8	-	-	-	-	1 black	-	-
533	EU 102	97.80-97.70	-	11	3.8	Indeterminate	-	-	-	Frags	-	11	-	-	-	-	-	-	-
533	EU 102	97.80-97.70	-	1	0.6	Turtle		Carapace		Medial		1	-	-	-	-	-	-	-
534	EU 102	97.70-97.60	-	5	2.0	Indeterminate	-	-	-	Frags	-	5	-	-	-	-	-	-	-
535	EU 103	98.59-98.40	-	4	2.4	Indeterminate	-	-	-	Frags	-	4	-	-	-	-	-	-	-
535	EU 103	98.59-98.40	-	1	0.1	Turtle	-	Carapace	-	Frags	-	1	-	-	-	-	-	-	-
536	EU 103	98.40-98.30	-	2	6.8	Deer	-	Inner ear	-	Medial	-	2	-	-	-	-	-	-	-
536	EU 103	98.40-98.30	-	1	2.5	Deer size	-	Long bone	-	Medial	-	1	-	-	-	-	-	-	-
536	EU 103	98.40-98.30	-	17	3.5	Indeterminate	-	-	-	Frags	-	17	-	-	-	-	-	-	-
537	EU 103	98.30-98.20	-	1	4.0	Bison size	-	Rib	-	Proximal	-	-	1	-	-	-	-	-	-
537	EU 103	98.30-98.20	-	6	1.7	Indeterminate	-	-	-	Frags	-	6	-	-	-	-	-	-	-
538	EU 104	98.66-98.50	-	1	0.2	Indeterminate	-	-	-	Frags	-	1	-	-	-	-	-	-	-
539	EU 104	98.5-98.40	-	2	8.4	Deer size	-	Long bone	-	Medial	-	-	2	-	-	-	-	5-6 thin	-
539	EU 104	98.5-98.40	-	19	4.6	Indeterminate	-	-	-	Frags	-	19	-	-	-	-	1 white, 1 black	-	-
540	EU 104	98.40-98.30	-	4	0.5	Indeterminate	-	-	-	Frags	-	4	-	-	-	-	-	-	-
542	EU 105	98.50-98.40	-	1	6.6	Deer size	-	Long bone	-	Medial	-	-	1	-	-	-	-	-	-
542	EU 105	98.50-98.40	-	7	4.1	Indeterminate	-	-	-	Frags	-	7	-	-	-	-	-	-	-
545	EU 106	98.40-98.30	-	1	35.6	Bison	-	Tooth, M2	-	Complete	-	-	1	-	-	-	-	-	-
545	EU 106	98.40-98.30	-	1	397.2	Bison	-	Femur	-	Medial	R	-	-	-	-	1	-	-	spiral fractured, rodent chewed

Appendix A, continued

Lot #	Unit	Elevation	Feature	Qty	Wt (g)	Taxon	Species	Element	Age	Portion	Side	Size, 0-3 cm	Size, 3-6 cm	Size, 6-9 cm	Size, 9-12 cm	Size, >12 cm	Burned (Color)	Cut Marks (Type)	Comments
545	EU 106	98.40-98.30	-	1	43.6	Bison size	-	Long bone	-	Medial	-	-	-	-	1	-	-	-	edges rounded
545	EU 106	98.40-98.30	-	7	13.6	Indeterminate	-	-	-	Frags	-	4	3	-	-	-	-	-	-
545	EU 106	98.40-98.30	-	1	0.2	Deer size	-	Sesimoid	-	Complete	-	1	-	-	-	-	-	-	-
545	EU 106	98.40-98.30	-	1	0.2	Deer	-	Antler	-	Medial	-	1	-	-	-	-	-	-	-
547	EU 106	98.20-98.10	-	1	0.4	Indeterminate	-	-	-	Frags	-	1	-	-	-	-	-	-	-
548	EU 107	98.50-98.40	-	4	1.1	Indeterminate	-	-	-	Frags	-	4	-	-	-	-	-	-	-
549	EU 107	98.40-98.30	-	4	3.0	Indeterminate	-	-	-	Frags	-	3	1	-	-	-	-	-	-
549	EU 107	98.40-98.30	-	1	3.2	Bison	-	Tooth, incisor	-	Complete	-	-	1	-	-	-	-	-	-
550	EU 107	98.30-98.20	-	1	0.4	Indeterminate	-	-	-	Frags	-	1	-	-	-	-	-	-	-
553	EU 108	98.70-98.60	-	10	23.5	Indeterminate	-	-	-	Frags	-	9	-	1	-	-	-	-	-
554	EU 108	98.60-98.50	-	2	0.3	Indeterminate	-	-	-	Frags	-	2	-	-	-	-	-	-	-
554	EU 108	98.60-98.50	-	2	4.7	Deer size	-	Long bone	-	Medial	-	1	1	-	-	-	2 brown/ black	-	-
555	EU 109	98.67-98.60	-	10	5.1	Indeterminate	-	-	-	Frags	-	9	1	-	-	-	-	-	-
555	EU 109	98.67-98.60	-	1	0.6	Turtle	-	Carapace	-	Medial	-	1	-	-	-	-	-	-	-
556	Eu 109	98.60-98.50	-	1	1.1	Deer size	-	Cuneiform pes	-	Complete	L	1	-	-	-	-	-	-	-
556	EU 109	98.60-98.50	-	1	9.7	Deer size	-	Radius	-	Proximal	R	-	1	-	-	-	-	-	odd, possible mule deer
556	EU 109	98.60-98.50	-	3	8.7	Deer size	-	Metapodial	-	Distal	-	2	1	-	-	-	-	-	-
556	EU 109	98.60-98.50	-	8	7.3	Indeterminate	-	-	-	Frags	-	7	1	-	-	-	-	-	-
557	EU 110	98.93-98.70	-	2	2.0	Deer size	-	Rib	-	Medial	-	1	1	-	-	-	-	-	-
558	EU 110	98.70-98.60	-	9	8.9	Indeterminate	-	-	-	Frags	-	7	2	-	-	-	-	-	-
558	EU 110	98.70-98.60	-	1	6.4	Carnivor	Raccoon	Mandible	-	Complete	L	-	-	1	-	-	-	-	-
561	EU 111	98.60-98.50	-	2	0.7	Indeterminate	-	-	-	Frags	-	2	-	-	-	-	-	-	-
562	EU 111	98.50-98.40	-	2	6.1	Deer size	-	Long bone	-	Medial	-	1	1	-	-	-	-	-	-
562	EU 111	98.50-98.40	-	4	3.1	Indeterminate	-	-	-	Frags	-	3	1	-	-	-	-	-	-
565	EU 112	98.70-98.60	-	1	78.4	Bison size	-	Metatarsal	-	Proximal	L	-	-	-	1	-	-	-	weathered, impact scar on midshaft
565	EU 112	98.70-98.60	-	1	0.5	Deer size	-	3rd Phalange	-	Medial	-	1	-	-	-	-	-	-	-
565	EU 112	98.70-98.60	-	1	0.7	Deer size	-	1st Phalange	-	Proximal	-	1	-	-	-	-	-	-	-
565	EU 112	98.70-98.60	-	3	9.2	Deer size	-	Rib	-	Medial	-	-	1	2	-	-	-	-	-
565	EU 112	98.70-98.60	-	1	0.3	Fish	-	Vertebra	-	Medial	-	1	-	-	-	-	-	-	-
565	EU 112	98.70-98.60	-	19	7.4	Indeterminate	-	-	-	Frags	-	18	1	-	-	-	-	-	-
567	EU 113	98.70-98.60	-	5	5.7	Indeterminate	-	-	-	Frags	-	5	-	-	-	-	4 black/ white	-	-
570	EU 115	98.70-98.60	-	2	3.3	Indeterminate	-	-	-	Frags	-	2	-	-	-	-	-	-	-
574	EU 119	98.70-98.60	-	14	4.6	Indeterminate	-	-	-	Frags	-	13	1	-	-	-	-	-	-
575	EU 119	98.60-98.50	-	7	7.0	Indeterminate	-	-	-	Frags	-	6	1	-	-	-	-	-	-
576	EU 120	98.50-98.40	-	2	2.1	Indeterminate	-	-	-	Frags	-	2	-	-	-	-	-	-	-
577	EU 120	98.40-98.30	-	8	21.7	Bison size	-	Rib	-	Medial	-	2	3	1	2	-	-	-	-
577	EU 120	98.40-98.30	-	1	1.0	Deer size	-	Cuneiform pes	-	Complete	R	1	-	-	-	-	-	-	-
577	EU 120	98.40-98.30	-	14	5.4	Indeterminate	-	-	-	Frags	-	13	1	-	-	-	-	-	-
578	EU 120	98.30-98.20	-	18	5.2	Indeterminate	-	-	-	Frags	-	17	1	-	-	-	-	-	-
578	EU 120	98.30-98.20	-	1	0.5	Indeterminate	-	-	?fetal	Frags	-	1	-	-	-	-	-	-	-
582	EU 123	98.70-98.60	-	153	64.4	Indeterminate	-	Rib	-	Frags	-	139	12	2	-	-	-	-	-
582	EU 123	98.70-98.60	-	1	0.1	Rodent size	-	Mandible	-	Complete	R	1	-	-	-	-	-	-	-

Appendix A, continued

Lot #	Unit	Elevation	Feature	Qty	Wt (g)	Taxon	Species	Element	Age	Portion	Side	Size, 0-3 cm	Size, 3-6 cm	Size, 6-9 cm	Size, 9-12 cm	Size, >12 cm	Burned (Color)	Cut Marks (Type)	Comments
582	EU 123	98.70-98.60	-	1	0.1	Rabbit size	-	Tooth, incisor	-	Complete	-	1	-	-	-	-	-	-	-
582	EU 123	98.70-98.60	-	1	0.1	Indeterminate	-	3rd Phalange	-	Complete	-	1	-	-	-	-	-	-	-
582	EU 123	98.70-98.60	-	1	0.1	Carnivor size	-	2nd Phalange	-	Complete	-	1	-	-	-	-	-	-	-
583	EU 123	98.60-98.50	-	3	2.6	Deer size	-	Rib	-	Medial	-	3	-	-	-	-	-	-	-
584	EU 124	98.23-98.10	-	7	13.8	Indeterminate	-	-	-	Frags	-	3	4	-	-	-	-	-	-
584	EU 124	98.23-98.10	-	1	0.1	Rabbit size	-	Long bone	-	Medial	-	1	-	-	-	-	-	-	-
585	EU 124	98.10-98.00	-	1	4.7	Turkey size	-	Humerus	-	Distal	R	-	-	1	-	-	-	3 thin	turkey size, spiral fractured
586	EU 124	98.08	-	1	48.0	Bison	-	Pelvis	-	Frags	R	-	-	-	-	1	-	-	-
586	EU 124	98.08	-	9	5.4	Indeterminate	-	-	-	Frags	-	8	1	-	-	-	1 white	-	-
587	EU 124	98.09	-	2	13.7	Bison size	-	Rib	-	Medial	-	-	-	1	-	1	-	-	-
588	EU 124	98.04	-	7	20.6	Bison size	-	Rib	-	Proximal	-	6	-	-	1	-	-	-	rodent chewed
589	EU 124	98.00-97.90	-	1	0.4	Indeterminate	-	-	-	Frags	-	1	-	-	-	-	-	-	-
590	EU 125	98.30-98.20	-	3	2.5	Indeterminate	-	-	-	Frags	-	3	-	-	-	-	-	-	-
591	EU 125	98.20-98.10	-	5	33.0	Bison size	-	Rib	-	Medial	-	-	3	1	-	1	-	3 tiny	-
591	EU 125	98.20-98.10	-	19	17.2	Indeterminate	-	-	-	Frags	-	15	4	-	-	-	2 black	3 tiny	-
592	EU 125	98.10-98.00	-	3	4.0	Indeterminate	-	-	-	Frags	-	3	-	-	-	-	-	-	-
593	EU 125	98.00-97.90	-	4	1.9	Indeterminate	-	-	-	Frags	-	4	-	-	-	-	-	-	-
593	EU 125	98.00-97.90	-	1	0.6	Deer size	-	Phalange	-	Distal	-	1	-	-	-	-	-	-	-
593	EU 125	98.00-97.90	-	1	0.1	Rodent size	-	Tibia	-	Complete	-	1	-	-	-	-	-	-	-
595	EU 126	98.30-98.20	-	6	2.3	Indeterminate	-	-	-	Frags	-	5	1	-	-	-	-	-	-
595	EU 126	98.30-98.20	-	1	6.6	Deer size	-	Long bone	-	Medial	-	-	-	1	-	-	-	-	spiral fractured
595	EU 126	98.30-98.20	-	1	0.2	Rabbit size	-	Ulna	-	Proximal	R	1	-	-	-	-	-	-	cottontail size
596	EU 126	98.20-98.10	-	1	5.3	Deer	-	Navicular cuboid	-	Complete	R	1	-	-	-	-	-	-	-
596	EU 126	98.20-98.10	-	1	0.9	Deer size	-	-	-	Frags	-	1	-	-	-	-	-	-	-
597	EU 126	98.10-98.00	-	1	4.3	Deer size	-	Long bone	-	Medial	-	-	1	-	-	-	-	-	-
598	EU 127	97.95-97.80	-	6	4.8	Indeterminate	-	-	-	Frags	-	4	2	-	-	-	-	-	-
599	EU 127	97.80-97.70	-	1	29.5	Bison size	-	Rib	-	Frags	-	-	-	-	-	1	-	few cuts	-
599	EU 127	97.80-97.70	-	1	6.8	Bison size	-	Long bone	-	Medial	-	-	-	1	-	-	-	-	-
599	EU 127	97.80-97.70	-	3	3.2	Turtle	-	Carapace	-	Medial	-	3	-	-	-	-	2 black	-	-
599	EU 127	97.80-97.70	-	6	2.7	Fish	Catfish	Skull	-	Medial	-	5	1	-	-	-	-	-	nice spine jaw
599	EU 127	97.80-97.70	-	1	1.4	Deer	-	2nd Phalange	-	Complete	-	1	-	-	-	-	-	-	-
599	EU 127	97.80-97.70	-	27	15.3	Indeterminate	-	-	-	Frags	-	25	2	-	-	-	1 white	-	-
599-1	EU 127	97.80-97.70	-	1	5.0	Indeterminate	-	-	-	Medial	-	-	-	-	1	-	-	-	awl like
600	EU 127	97.70-97.60	-	1	70.3	Bison size	-	Rib	-	Medial	-	-	-	-	-	1	-	-	rodent chewed
600	EU 127	97.70-97.60	-	1	331.3	Bison size	-	Tibia	Mature	Proximal	R	-	-	-	-	1	-	5 thin	spiral fractured, impact scars, heat damaged
600	EU 127	97.70-97.60	-	3	8.9	Deer size	-	Vertebra	Immature	Medial	-	1	-	-	-	-	-	-	-
600	EU 127	97.70-97.60	-	1	10.4	Bison size	-	Long bone	-	Medial	-	-	-	1	-	-	-	-	-
600	EU 127	97.70-97.60	-	1	1.8	Bison size	-	Vertebra	-	End	-	1	-	-	-	-	-	-	-
600	EU 127	97.70-97.60	-	8	5.2	Deer size	-	Vertebra	-	Frags	-	8	-	-	-	-	-	-	-
600	EU 127	97.70-97.60	-	2	0.6	Turtle	-	Carapace	-	Frags	-	2	-	-	-	-	-	-	-
600	EU 127	97.70-97.60	-	6	1.5	Fish	-	Skull	-	Frags	-	6	-	-	-	-	-	-	-
600	EU 127	97.70-97.60	-	1	0.2	Fish	-	Vertebra	-	Frags	-	1	-	-	-	-	-	-	-

Appendix A, continued

Lot #	Unit	Elevation	Feature	Qty	Wt (g)	Taxon	Species	Element	Age	Portion	Side	Size, 0-3 cm	Size, 3-6 cm	Size, 6-9 cm	Size, 9-12 cm	Size, >12 cm	Burned (Color)	Cut Marks (Type)	Comments
600	EU 127	97.70-97.60	-	1	4.3	Deer size	-	Long bone	-	Medial	-	-	1	-	-	-	partially black	-	-
600	EU 127	97.70-97.60	-	19	3.3	Indeterminate	-	-	-	Frags	-	19	-	-	-	-	2 black	-	-
601	EU 127	97.60-97.50	-	1	0.2	Indeterminate	-	-	-	Frags	-	1	-	-	-	-	-	-	-
602	EU 128	98.05-97.90	-	1	0.1	Indeterminate	-	-	-	Frags	-	1	-	-	-	-	-	-	-
603	EU 128	97.90-97.80	-	32	26.9	Bison size	-	Rib	-	Frags	-	25	4	3	-	-	-	-	-
603	EU 128	97.90-97.80	-	2	1.3	Indeterminate	-	Long bone	-	Frags	-	2	-	-	-	-	1 white/ brown	-	-
603	EU 128	97.90-97.80	-	1	0.2	Turtle	-	Carapace	-	Medial	-	1	-	-	-	-	-	-	-
604	EU 128	97.80-97.70	-	1	21.9	Deer	-	Tibia	-	Distal	L	-	-	-	1	-	-	7 thin	spiral fractured
604	EU 128	97.80-97.70	-	1	44.3	Bison size	-	Vertebra, lumbar	Immature	Medial	-	-	-	-	1	-	-	-	-
604	EU 128	97.80-97.70	-	1	66.3	Bison size	-	Vertebra, cervical	Immature	Medial	-	-	-	-	1	-	-	3 thin	rodent chewed
604	EU 128	97.80-97.70	-	1	5.5	Deer size	-	Long bone	-	Medial	-	-	-	1	-	-	-	-	spiral fractured
604	EU 128	97.80-97.70	-	7	7.8	Fish	Catfish	Skull	-	Medial	-	5	2	-	-	-	-	-	mandible with tiny holes
604	EU 128	97.80-97.70	-	15	15.2	Indeterminate	-	-	-	Frags	-	10	5	-	-	-	1 black	-	-
604	EU 128	97.80-97.70	-	1	37.4	Bison	-	Femur	-	Distal	-	-	1	-	-	-	-	-	-
605	EU 129	98.05-97.90	-	3	3.5	Indeterminate	-	-	-	Frags	-	3			-	-	-	-	-
606	EU 129	97.90-97.80	-	3	6.4	Bison size	-	Rib	-	Medial	-	2	1	-	-	-	-	-	-
606	EU 129	97.90-97.80	-	8	14.8	Deer size	-	Long bone	-	Medial	-	4	4	-	-	-	-	-	-
606	EU 129	97.90-97.80	-	2	2.2	Bison size	-	Long bone	poss fetal	Medial	-	2	-	-	-	-	-	-	-
606	EU 129	97.90-97.80	-	34	11.3	Indeterminate	-	-	-	Frags	-	31	3	-	-	-	-	-	-
607	EU 129	97.80-97.70	-	14	10.5	Indeterminate	-	-	-	Frags	-	11	3	-	-	-	-	-	-
607-1	EU 129	97.80-97.70	-	1	1.3	Deer	-	Antler	-	Tip	-	1	-	-	-	-	white	-	-
609	EU 130	98.10-98.00	-	3	3.9	Indeterminate	-	-	-	Frags	-	3	-	-	-	-	-	-	-
610	EU 130	98.00-97.90	-	5	2.2	Indeterminate	-	-	-	Frags	-	5	-	-	-	-	-	-	-
610	EU 130	98.00-97.90	-	1	0.3	Deer	-	Sesimoid	-	Complete	-	1	-	-	-	-	-	-	-
611	EU 131	98.22-98.10	-	3	12.1	Bison size	-	Rib	-	Medial	-	1	1	1	-	-	-	-	-
611	EU 131	98.22-98.10	-	4	2.2	Indeterminate	-	-	-	Frags	-	4	-	-	-	-	-	-	-
612	EU 131	98.10-98.00	-	1	4.1	Bison size	-	Rib	-	Medial	-	-	1	-	-	-	-	-	-
614	EU 132	98.38-98.20	-	5	2.1	Indeterminate	-	-	-	Frags	-	5	-	-	-	-	-	-	-
615	EU 132	98.20-98.10	-	1	1.8	Deer size	-	1st Phalange	-	Distal	-	1	-	-	-	-	-	-	-
615	EU 132	98.20-98.10	-	5	1.3	Indeterminate	-	-	-	Frags	-	5	-	-	-	-	-	-	-
616	EU 132	98.10-98.00	-	1	0.3	Rodent size	-	Mandible	-	Medial	L	1	-	-	-	-	-	-	-
616	EU 132	98.10-98.00	-	1	0.9	Bison size	-	Rib	-	Medial	-	1	-	-	-	-	-	-	-
616	EU 132	98.10-98.00	-	3	0.6	Indeterminate	-	-	-	Frags	-	3	-	-	-	-	-	-	-
617	EU 133	97.90-97.80	-	1	2.6	Bison size	-	Rib	-	Frags	-	1	-	-	-	-	-	-	-
617	EU 133	97.90-97.80	-	16	4.9	Indeterminate	-	-	-	Frags	-	16	-	-	-	-	-	-	-
617-2	EU 133	97.90-97.80	-	1	2.6	Indeterminate	-	-	-	Frags	-	-	1	-	-	-	-	-	awl like, rodent clawed
740	EU 133	97.80-97.70	-	1	170.0	Bison	-	Femur	Mature	Proximal	R	-	-	-	-	1	-	Lots	-
740	EU 133	97.80-97.70	-	6	161.1	Bison size	-	Femur	-	Medial	R	-	3	1	-	2	-	-	impact scar, rodent chewed
740	EU 133	97.80-97.70	-	3	3.0	Deer size	-	Long bone	-	Medial	-	2	1	-	-	-	-	-	-
740	EU 133	97.80-97.70	-	1	0.2	Snake		Vertebra		Complete	-	1	-	-	-	-	-	-	-
740	EU 133	97.80-97.70	-	2	2.0	Fish	-	Skull	-	Frags	-	2	-	-	-	-	-	-	-
740	EU 133	97.80-97.70	-	3	2.0	Turtle	-	Carapace	-	Frags	-	3	-	-	-	-	-	-	-

Appendix A, continued

Lot #	Unit	Elevation	Feature	Qty	Wt (g)	Taxon	Species	Element	Age	Portion	Side	Size, 0-3 cm	Size, 3-6 cm	Size, 6-9 cm	Size, 9-12 cm	Size, >12 cm	Burned (Color)	Cut Marks (Type)	Comments
740	EU 133	97.80-97.70	-	52	34.8	Indeterminate	-	-	-	Frags	-	-	4	-	-	-	2 black	-	-
618	EU 133	97.70-97.60	-	4	16.1	Bison size	-	Rib	-	Medial	-	-	2	2	-	-	-	-	-
618	EU 133	97.70-97.60	-	2	0.7	Rabbit size	-	Long bone	-	Medial	-	1	1	-	-	-	-	-	-
618	EU 133	97.70-97.60	-	1	4.8	Deer size	-	Long bone	-	Medial	-	-	1	-	-	-	-	-	spiral fractured, impact fracture
618	EU 133	97.70-97.60	-	2	2.1	Fish	-	Skull	-	Medial	-	1	1	-	-	-	-	-	-
618	EU 133	97.70-97.60	-	1	0.4	Fish	-	Vertebra	-	Medial	-	1	-	-	-	-	-	-	-
618	EU 133	97.70-97.60	-	22	9.3	Indeterminate	-	-	-	Frags	-	20	2	-	-	-	-	-	-
619	EU 133	97.62	-	1	92.2	Bison	-	Vertebra, thoracic	Immature	Complete	-	-	-	-	1	-	-	7 thin, lots	rodent chewed
620	EU 133	97.60-97.50	-	8	27.6	Deer	-	Tibia	immature	Proximal	R	4	3	2	-	-	-	-	unfused end and medial
620	EU 133	97.60-97.50	-	3	20.0	Deer size	-	Long bone	-	Medial	-	1	1	1	-	-	-	-	-
620	EU 133	97.60-97.50	-	9	5.7	Indeterminate	-	-	-	Frags	-	6	1	-	-	-	-	-	-
620-1	EU 133	97.60-97.580	-	1	0.4	Deer	-	Antler	-	Tip	-	1	-	-	-	-	white	-	-
621	EU 134	97.94-97.80	-	2	7.7	Bison size	-	Rib	-	Medial	-	-	1	-	1	-	-	-	-
621	EU 134	97.94-97.80	-	1	2.2	Deer size	-	Long bone	-	Medial	-	-	1	-	-	-	-	-	-
621	EU 134	97.94-97.80	-	14	6.4	Indeterminate	-	-	-	Frags	-	12	2	-	-	-	2 black	-	1 rodent chewed
622	EU 134	97.80-97.70	-	5	2.4	Indeterminate	-	-	-	Frags	-	4	1	-	-	-	-	-	-
623	EU 134	97.70-97.60	-	11	3.5	Indeterminate	-	-	-	Frags	-	11	-	-	-	-	1 white	-	-
623	EU 134	97.70-97.60	-	1	1.3	Bison size	-	Skull	?fetal	Frags	-	1	-	-	-	-	-	-	no cortical tissue
624	EU 135	97.90-97.80	-	3	7.6	Bison size	-	Rib	-	Medial	-	1	2	-	-	-	-	-	-
624	EU 135	97.90-97.80	-	7	4.4	Indeterminate	-	-	-	Frags	-	6	1	-	-	-	-	-	-
625	EU 135	97.80-97.70	-	24	4.9	Indeterminate	-	-	-	Frags	-	23	1	-	-	-	-	-	-
625	EU 135	97.80-97.70	-	1	0.5	Fish	-	Skull	-	Medial	-	1	-	-	-	-	-	-	-
627	EU 136	97.92-97.80	-	1	4.1	Bison size	-	Rib	-	Medial	-	-	1	-	-	-	-	-	-
627	EU 136	97.92-97.80	-	1	2.2	Deer size	-	Long bone	-	Medial	-	1	-	-	-	-	-	-	-
627	EU 136	97.92-97.80	-	5	1.9	Indeterminate	-	-	-	Frags	-	5	-	-	-	-	-	-	-
628	EU 136	97.80-97.70	-	1	11.1	Bison size	-	Rib	-	Medial	-	-	-	-	1	-	-	-	-
628	EU 136	97.80-97.70	-	2	13.4	Deer size	-	Long bone	-	Medial	-	-	2	-	-	-	-	-	impact scar
628	EU 136	97.80-97.70	-	2	4.8	Deer size	-	Rib	-	Medial	-	-	2	-	-	-	-	-	-
628	EU 136	97.80-97.70	-	1	7.9	Bison size	-	Long bone	-	Medial	-	-	1	-	-	-	-	-	-
628	EU 136	97.80-97.70	-	14	7.8	Indeterminate	-	-	-	Frags	-	14	-	-	-	-	1 white	-	-
628	EU 136	97.80-97.70	-	1	0.1	Turtle	-	Carapace	-	Distal	-	1	-	-	-	-	-	-	-
629	EU 136	97.70-97.60	-	1	36.4	Bison size	-	Long bone	-	Medial	-	-	-	1	-	-	-	many thin tiny cuts	spiral fractured, impact scars
629	EU 136	97.70-97.60	-	2	0.5	Fish	-	Skull	-	Frags	-	2	-	-	-	-	-	-	-
629	EU 136	97.70-97.60	-	1	0.6	? Bird	-	Long bone	-	Medial	-	1	-	-	-	-	-	-	cancellous tissue inside
629	EU 136	97.70-97.60	-	16	5.9	Indeterminate	-	-	-	Frags	-	16	-	-	-	-	-	-	-
630	EU 136	97.71-97.68	-	1	66.6	Bison		Ulna	-	Medial	L	-	-	-	-	1	-	thin shallow	minor rodent chewed
631	EU 136	97.60-97.50	-	1	32.2	Bison size	-	Long bone	-	Medial	-	-	-	1	-	-	-	-	weathered surface
631	EU 136	97.60-97.50	-	1	0.3	Deer size	-	Vertebra	-	Distal	-	1	-	-	-	-	-	-	-

Appendix A, continued

Lot #	Unit	Elevation	Feature	Qty	Wt (g)	Taxon	Species	Element	Age	Portion	Side	Size, 0-3 cm	Size, 3-6 cm	Size, 6-9 cm	Size, 9-12 cm	Size, >12 cm	Burned (Color)	Cut Marks (Type)	Comments
632	EU 137	98.01-97.90	-	1	0.2	Indeterminate	-	-	-	Frags	-	1	-	-	-	-	-	-	-
633	EU 137	97.90-97.80	-	2	0.3	Indeterminate	-	-	-	Frags	-	1	-	-	-	-	2 black	-	-
634	EU 137	97.80-97.70	-	1	60.2	Bison	-	Navicular cuboid	-	Complete	L	-	1	-	-	-	-	3 on edge	-
634	EU 137	97.80-97.70	-	22	12.4	Indeterminate	-	-	-	Frags	-	19	3	-	-	-	-	-	-
635	EU 137	99.70-97.60	-	2	0.4	Indeterminate	-	-	-	Frags	-	2	-	-	-	-	-	-	-
638	EU 138	97.80-97.70	-	1	18.5	Deer	-	Metatarsal	-	Distal	R	-	-	1	-	-	-	multiple thin tiny	spiral fractured, red staining
638	EU 138	97.80-97.70	-	1	0.8	Rabbit size	-	Long bone	-	Medial	-	-	1	-	-	-	-	-	-
638	EU 138	97.80-97.70	-	4	8.7	Deer size	-	-	-	Frags	-	3	1	-	-	-	-	-	-
638	EU 138	97.80-97.70	-	11	5.8	Indeterminate	-	-	-	Frags	-	11	-	-	-	-	-	-	-
639	EU 138	97.70-97.60	-	2	1.2	Deer size	-	Long bone	-	Medial	-	2	-	-	-	-	-	-	-
641	EU 139	97.90-97.80	-	2	0.4	Indeterminate	-	-	-	Frags	-	2	-	-	-	-	-	-	-
642	EU 139	97.80-97.70	-	1	0.4	Rabbit size	-	Long bone	-	Medial	-	1	-	-	-	-	-	-	-
642	EU 139	97.80-97.70	-	11	4.3	Deer size	-	Rib	-	Medial	-	7	3	-	-	-	-	-	-
643	EU 139	97.70-97.60	-	1	3.3	Bison size	-	Rib	-	Proximal	-	-	1	-	-	-	-	-	-
643	EU 139	97.70-97.60	-	4	1.4	Indeterminate	-	-	-	Frags	-	4	-	-	-	-	-	-	-
644	EU 139	97.6-97.50	-	1	1.9	Bison size	-	Long bone	-	Medial	-	1	-	-	-	-	-	-	-
644	EU 139	97.6-97.50	-	10	1.8	Indeterminate	-	-	-	Frags	-	10	-	-	-	-	-	-	-
645	EU 140	97.86-97.67	-	3	385.4	Bison	-	Humerus	-	Proximal	R	1	1	-	-	1	-	-	spiral fractured, massive rodent chewed, heat altered
646	EU 140	98.06-97.90	-	1	1.6	Indeterminate	-	-	-	Frags	-	-	1	-	-	-	-	-	rounded edges
647	EU 140	97.90-97.80	-	7	6.6	Indeterminate	-	-	-	Frags	-	5	2	-	-	-	1 black	-	-
648	EU 140	97.80-97.70	-	29	12.7	Indeterminate	-	-	-	Frags	-	28	1	-	-	-	-	-	-
648	EU 140	97.80-97.70	-	1	0.1	Rabbit size	-	Long bone	-	Medial	-	1	-	-	-	-	-	-	-
649	EU 140	97.70-97.60	-	1	12.5	Bison size	-	Long bone	-	Medial	-	-	-	1	-	-	-	-	spiral fractured, fresh cuts
649	EU 140	97.70-97.60	-	13	9.3	Indeterminate	-	-	-	Frags	-	11	2	-	-	-	-	-	-
650	EU 141	97.94-97.91	-	1	0.8	Deer size	-	Tooth	-	Frags	-	1	-	-	-	-	-	-	-
650	EU 141	97.94-97.91	-	11	3.5	Indeterminate	-	-	-	Frags	-	11	-	-	-	-	1 black	-	-
651	EU 141	97.80-97.70	-	31	13.7	Indeterminate	-	-		Frags	-	28	3	-	-	-	1 white	-	-
652	EU 141	97.70-97.60	-	1	1.6	Pronghorn	-	3rd Phalange	-	Complete	-	1	-	-	-	-	-	-	-
652	EU 141	97.70-97.60	-	1	0.2	Deer size	-	Dew claw	-	Complete	-	1	-	-	-	-	-	-	-
652	EU 141	97.70-97.60	-	13	4.1	Indeterminate	-	-	-	Frags	-	-	-	-	-	-	-	-	-
652	EU 141	97.70-97.60	-	1	5.5	Deer size	-	Pelvis	-	Medial	-	-	-	1	-	-	-	-	-
653	EU 142	98.61-98.50	-	4	1.9	Deer size	-	Rib	-	Frags	-	4	-	-	-	-	-	-	-
654	EU 142	98.50-98.40	-	15	5.9	Indeterminate	-	-	-	Frags	-	12	3	-	-	-	-	-	-
655	EU 142	98.40-98.30	-	4	1.6	Indeterminate	-	-	-	Frags	-	4	-	-	-	-	-	-	-
655	EU 142	98.40-98.30	-	1	2.5	Carnivor	Raccoon	Mandible	-	Medial	R	-	1	-	-	-	-	-	weathered
657	EU 143	98.50-98.40	-	5	2.4	Deer size	-	Rib	-	Frags	-	5	-	-	-	-	-	-	-
657	EU 143	98.50-98.40	-	1	3.4	Deer size	-	Metacarpal	-	Distal	R	-	1	-	-	-	-	-	-
658	EU 143	98.40-98.30	-	1	5.5	Deer size	-	Inner ear	-	Complete	-	1	-	-	-	-	-	-	-
658	EU 143	98.40-98.30	-	2	2.3	Deer size	-	Long bone	-	Medial	-	2	-	-	-	-	-	-	-
658	EU 143	98.40-98.30	-	1	0.3	Rabbit size	-	Long bone	-	Medial	-	1	-	-	-	-	1 black	-	-

Appendix A, continued

Lot #	Unit	Elevation	Feature	Qty	Wt (g)	Taxon	Species	Element	Age	Portion	Side	Size, 0-3 cm	Size, 3-6 cm	Size, 6-9 cm	Size, 9-12 cm	Size, >12 cm	Burned (Color)	Cut Marks (Type)	Comments
658	EU 143	98.40-98.30	-	1	0.4	Rabbit size	Jack Rabbit	Humerus	-	Distal	-	1	-	-	-	-	-	-	-
660	EU 144	98.50-98.40	-	1	1.2	Bison size	-	Rib	-	Medial	-	1	-	-	-	-	-	-	-
661	EU 144	98.40-98.30	-	6	2.6	Indeterminate	-	-	-	Frags	-	6	-	-	-	-	2 white	-	-
662	EU 145	97.80-97.70	-	1	43.0	Bison size	-	Long bone	-	Medial	-	-	-	1	-	-	-	-	-
662	EU 145	97.80-97.70	-	1	8.5	Bison size	-	Rib	-	Medial	-	-	-	-	1	-	-	-	rodent chewed
662	EU 145	97.80-97.70	-	1	13.3	Deer size	-	Long bone	-	Medial	-	-	-	-	1	-	-	30+	impact scar
662	EU 145	97.80-97.70	-	1	1.0	Rabbit size	-	Long bone	-	Medial	-	-	1	-	-	-	-	-	-
662	EU 145	97.80-97.70	-	1	1.1	Bison size	-	Mandible?	?fetal	Frags	-	1	-	-	-	-	-	-	-
662	EU 145	97.80-97.70	-	3	0.5	Fish	-	Skull	-	Frags	-	3	-	-	-	-	-	-	-
662	EU 145	97.80-97.70	-	1	3.5	Deer size	-	Metapodial	-	Proximal	-	1	-	-	-	-	-	-	-
662	EU 145	97.80-97.70	-	37	15.2	Indeterminate	-	-	-	Frags	-	34	3	-	-	-	-	cuts on 1	-
663	EU 145	97.70-97.60	-	1	6.3	Bison	-	Malleolus lateral	-	Complete	L	1	-	-	-	-	-	-	-
663	EU 145	97.70-97.60	-	2	3.3	Fish	-	Vertebra	-	Complete	-	2	-	-	-	-	-	-	-
663	EU 145	97.70-97.60	-	1	0.6	Fish	-	Skull	-	Medial	-	1	-	-	-	-	-	-	-
663	EU 145	97.70-97.60	-	1	2.2	Bison size	-	Rib	-	Frags	-	1	-	-	-	-	-	-	-
663	EU 145	97.70-97.60	-	22	6.9	Deer size	-	Rib	-	Medial	-	18	4	-	-	-	-	-	-
664	EU 145	97.60-97.50	-	2	0.2	Indeterminate	-	-	-	Frags	-	2	-	-	-	-	-	-	-
733	EU 145	97.64	-	1	141.7	Bison	-	Tibia	-	Distal	L	-	-	-	-	1	-	20+ tiny	spiral fractured
734	EU 145	97.64	-	2	5.9	Fish	-	Skull	-	Medial	-	-	2	-	-	-	-	-	large
735	EU 145	97.71	-	6	83.2	Bison size	-	Rib	-	Medial	-	1	3	-	1	1	-	15+tiny, 13+tiny	-
736	EU 145	97.62	-	1	361.2	Bison	-	Humerus	Mature	Proximal	L	-	-	-	-	1	-	-	chop marks, spiral fractured
736	EU 145	97.62	-	15	0.6	Indeterminate	-	-	-	Frags	-	15	-	-	-	-	2 black	-	-
665	EU 146	97.84-97.70	-	5	4.0	Fish	-	Skull	-	Frags	-	5	-	-	-	-	-	-	-
665	EU 146	97.84-97.70	-	1	0.2	Rodent	-	Mandible	-	Complete	R	1	-	-	-	-	-	-	-
665	EU 146	97.84-97.70	-	1	0.1	Rabbit size	-	Long bone	-	Medial	-	1	-	-	-	-	3 black	-	-
665	EU 146	97.84-97.70	-	35	13.2	Indeterminate	-	-	-	Frags	-	33	2	-	-	-	-	-	-
666	EU 146	97.70-97.60	-	4	11.9	Bison size	-	Rib	-	Medial	-	-	-	3	-	-	-	-	-
666	EU 146	97.70-97.60	-	2	9.4	Indeterminate	-	-	-	-	-	-	2	1	-	-	-	-	weird flat, unusual surfaces
666	EU 146	97.70-97.60	-	21	9.2	Indeterminate	-	-	-	Frags	-	19	2	-	-	-	3 white/ black	-	-
666	EU 146	97.70-97.60	-	1	0.1	Turtle	-	Carapace	-	Frags	-	1	-	-	-	-	-	-	-
666	EU 146	97.70-97.60	-	19	5.4	Fish	-	Skull	-	Frags	-	19	-	-	-	-	-	-	-
666	EU 146	97.70-97.60	-	1	0.7	Fish	-	Vertebra	-	Complete	-	1	-	-	-	-	-	-	-
667	EU 146	97.60-97.50	-	3	0.9	Indeterminate	-	Rib	-	Frags	-	3	-	-	-	-	-	-	-
737	EU 146	97.64	-	9	28.8	Bison size	-	Rib	-	Frags	-	1	3	5	-	-	-	9 thin	-
738	EU 146	97.64	-	2	133.8	Bison size	-	Rib	-	Medial	-	-	-	-	-	2	-	9 thin	-
739	EU 146	97.64	-	4	109.7	Bison size	-	Femur	-	Distal	R	-	-	3	-	1	-	-	spiral fractured
670	EU 147	97.80-97.70	-	1	24.7	Bison	-	2nd Phalange	-	Complete	-	-	1	-	-	-	-	-	large
670	EU 147	97.80-97.70	-	1	59.4	Bison size	-	Humerus	-	Proximal	-	-	-	1	-	-	-	-	-
670	EU 147	97.80-97.70	-	4	17.9	Bison size	-	-	-	Frags	-	-	4	-	-	-	-	-	-
670	EU 147	97.80-97.70	-	2	0.6	Turtle	-	Carapace	-	Frags	-	2	-	-	-	-	1 black	-	-
670	EU 147	97.80-97.70	-	27	7.6	Indeterminate	-	-	-	Frags	-	25	2	-	-	-	2 white, 1 black	-	-

Appendix A, continued

Lot #	Unit	Elevation	Feature	Qty	Wt (g)	Taxon	Species	Element	Age	Portion	Side	Size, 0-3 cm	Size, 3-6 cm	Size, 6-9 cm	Size, 9-12 cm	Size, >12 cm	Burned (Color)	Cut Marks (Type)	Comments
671	EU 147	97.70-97.60	-	1	33.4	Bison	-	Magnum	-	Complete	L	-	1	-	-	-	-	-	rodent chewed
671	EU 147	97.70-97.60	-	4	24.9	Bison size	-	Rib	-	Medial	-	-	2	1	-	1	-	lots near proximal	rodent chewed
671	EU 147	97.70-97.60	-	1	22.0	Bison	-	Spine	-	Medial	-	-	-	-	1	-	-	14+ long cuts	-
671	EU 147	97.70-97.60	-	28	11.3	Indeterminate	-	-	-	Frags	-	25	3	-	-	-	5 white	-	-
671	EU 147	97.70-97.60	-	1	0.8	Deer size	-	Metapodial	-	Distal	-	1	-	-	-	-	-	-	-
671	EU 147	97.70-97.60	-	2	0.9	Fish	-	Vertebra	-	Complete	-	2	-	-	-	-	-	-	-
671	EU 147	97.70-97.60	-	12	5.0	Fish	-	Skull	-	Frags	-	-	1	-	-	-	-	-	-
672	EU 148	97.99-97.90	-	8	2.2	Indeterminate	-	-	-	Frags	-	8	-	-	-	-	-	-	-
673	EU 148	97.90-97.80	-	1	2.7	Deer	-	Tooth, PM2	-	Complete	L	1	-	-	-	-	-	-	large
673	EU 148	97.90-97.80	-	1	0.2	Snake	-	Vertebra	-	Complete	-	1	-	-	-	-	-	-	-
673	EU 148	97.90-97.80	-	25	5.4	Indeterminate	-	-	-	Frags	-	25	-	-	-	-	4 black	-	-
674	EU 148	98.80-97.70	-	1	1.9	Bison size	-	Rib	-	Medial	-	1	-	-	-	-	brown/black	7	well defined
674	EU 148	98.80-97.70	-	1	0.1	Turtle	-	Carapace	-	Lateral	-	1	-	-	-	-	-	-	-
674	EU 148	98.80-97.70	-	1	0.3	Fish	-	Rib	-	Medial	-	-	1	-	-	-	-	-	-
674	EU 148	98.80-97.70	-	1	1.2	Fish	-	Vertebra	-	Complete	-	1	-	-	-	-	-	-	-
674	EU 148	98.80-97.70	-	66	21.2	Indeterminate	-	-	-	Frags	-	63	3	-	-	-	-	-	-
675	EU 148	97.68	-	11	15.4	Deer	-	Maxilla, 5 teeth	young	Complete	L	11	-	-	-	-	-	-	teeth not in full wear
676	EU 148	97.72	-	2	110.2	Bison size	-	Rib	-	Medial	-	-	-	-	-	2	-	-	-
677	EU 148	97.70-97.60	-	1	118.0	Bison	-	Radius	-	Proximal	R	-	-	-	-	1	-	-	spiral fractured
677	EU 148	97.70-97.60	-	6	96.1	Bison size	-	Rib	-	Medial	-	-	-	-	2	4	-	1 chop	rodent chewed
677	EU 148	97.70-97.60	-	48	25.2	Indeterminate	-	-	-	Frags	-	-	4	-	-	-	1 gray	-	-
678	EU 149	98.10-97.90	-	8	4.5	Indeterminate	-	-	-	Frags	-	7	1	-	-	-	-	-	-
679	EU 149	97.90-97.80	-	20	3.1	Indeterminate	-	-	-	-	-	20	-	-	-	-	-	-	-
680	EU 149	97.80-97.70	-	1	13.3	Bison	-	Cuneiform pes	-	Complete	R	-	1	-	-	-	-	-	-
680	EU 149	97.80-97.70	-	1	35.8	Bison	-	Tooth, maxillary, M2	young	Complete	R	-	-	1	-	-	-	-	tooth not in wear-erupting
680	EU 149	97.80-97.70	-	1	19.7	Bison size	-	Long bone	-	Medial	-	-	1	-	-	-	-	-	spiral fractured, chop mark?
680	EU 149	97.80-97.70	-	1	6.9	Bison size	-	Rib	-	Medial	-	-	-	1	-	-	-	-	-
680	EU 149	97.80-97.70	-	1	6.6	Deer size	-	Long bone	-	Medial	-	-	-	1	-	-	-	6 tiny	-
680	EU 149	97.80-97.70	-	1	0.7	Rabbit size	-	Long bone	-	Medial	-	-	1	-	-	-	-	-	-
680	EU 149	97.80-97.70	-	3	1.6	Fish	Catfish	Skull	-	Frags	-	3	-	-	-	-	-	-	-
680	EU 149	97.80-97.70	-	1	0.8	Bison size	-	Long bone	fetal	Frags	-	1	-	-	-	-	-	-	-
680	EU 149	97.80-97.70	-	77	44.5	Indeterminate	-	-	-	Frags	-	66	11	-	-	-	2 white, 1 black	-	-
681	EU 149	97.70-97.60	-	1	5.2	Deer size	-	Long bone	-	Medial	-	-	1	-	-	-	-	-	-
681	EU 149	97.70-97.60	-	1	2.7	Deer size	-	Rib	-	Medial	-	-	1	-	-	-	-	-	-
681	EU 149	97.70-97.60	-	10	4.2	Indeterminate	-	-	-	Frags	-	10	-	-	-	-	-	-	-
681	EU 149	97.70-97.60	-	1	0.1	Bird	-	Humerus	-	Distal	R	1	-	-	-	-	-	-	small
681	EU 149	97.70-97.60	-	1	0.4	Carnivor	-	Mandible	-	Medial	R	1	-	-	-	-	-	-	-
682	EU 150	98.72-98.60	-	1	0.2	Indeterminate	-	-	-	Frags	-	1	-	-	-	-	white	-	-
683	EU 150	98.60-98.50	-	17	0.9	Indeterminate	-	-	-	Frags	-	14	3	-	-	-	-	-	-
684	EU 150	98.50-98.40	-	6	4.4	Indeterminate	-	-	-	Frags	-	5	1	-	-	-	-	-	-
741	EU 151	98.60-98.50	-	1	4.4	Deer size	-	Long bone	-	Medial	-	-	1	-	-	-	-	-	spiral fractured
741	EU 151	98.60-98.50	-	13	4.6	Indeterminate	-	-	-	Frags	-	12	1	-	-	-	-	-	-

Appendix A, continued

Lot #	Unit	Elevation	Feature	Qty	Wt (g)	Taxon	Species	Element	Age	Portion	Side	Size, 0-3 cm	Size, 3-6 cm	Size, 6-9 cm	Size, 9-12 cm	Size, >12 cm	Burned (Color)	Cut Marks (Type)	Comments
686	EU 151	98.50-98.40	-	1	16.3	Deer	-	Astragalus	-	Complete	R	-	1	-	-	-	-	-	rodent chewed
686	EU 151	98.50-98.40	-	1	21.9	Deer	-	Humerus	-	Distal	R	-	1	-	-	-	-	-	spiral fractured
686	EU 151	98.50-98.40	-	3	2.9	Indeterminate	-	-	-	Frags	-	2	1	-	-	-	-	-	-
687	EU 151	98.40-98.30	-	1	1.3	Indeterminate	-	-	-	Frags	-	1	-	-	-	-	-	-	-
688	EU 152	98.6-98.5	-	1	0.2	Indeterminate	-	-	-	Frags	-	1	-	-	-	-	white	-	-
689	EU 152	98.50-98.40	-	1	0.2	Indeterminate	-	-	-	Frags	-	1	-	-	-	-	-	-	-
690	EU 152	98.50-98.40	-	1	0.1	Fish	-	Rib	-	Medial	-	1	-	-	-	-	-	-	-
690	EU 152	98.50-98.40	-	10	11.1	Indeterminate	-	-	-	Frags	-	5	5	-	-	-	-	-	-
692	EU 153	97.84-97.70	-	2	22.4	Bison size	-	Rib	-	Medial	-	-	-	-	1	1	-	-	-
692	EU 153	97.84-97.70	-	1	11.8	Bison	-	Cuneiform pes	-	Complete	R	-	1	-	-	-	-	-	-
692	EU 153	97.84-97.70	-	1	26.3	Bison	-	Cuneiform pes	-	Complete	R	-	1	-	-	-	-	-	-
692	EU 153	97.84-97.70	-	2	0.5	Rabbit size	-	Long bone	-	Frags	-	2	-	-	-	-	-	-	-
692	EU 153	97.84-97.70	-	31	35.6	Indeterminate	-	-	-	Frags	-	26	4	1	-	-	-	-	-
692	EU 153	97.84-97.70	-	1	0.2	Deer	-	Tooth	-	Frags	-	1	-	-	-	-	-	-	-
692	EU 153	97.84-97.70	-	1	2.7	Indeterminate	-	-	-	Frags	-	1	-	-	-	-	-	multi thin	grooves at snap end
693	EU 153	97.70-97.60	-	1	78.3	Bison size	-	Rib	-	Medial	-	-	-	-	-	1	-	lots	-
693	EU 153	97.70-97.60	-	1	155.4	Bison	-	Metatarsal	Mature	Distal	L	-	-	-	-	1	-	18 thin	spiral fractured, weathered
742	EU 153	97.70-97.60	-	2	10.1	Bison size	-	Rib	-	Medial	-	-	-	2	-	-	-	6-8	-
742	EU 153	97.70-97.60	-	1	0.9	Fish	-	Skull	-	Medial	-	1	-	-	-	-	-	-	-
742	EU 153	97.70-97.60	-	27	16.9	Indeterminate	-	-	-	Frags	-	23	4	-	-	-	-	-	-
694	EU 153	97.60-97.50	-	1	0.7	Indeterminate	-	-	-	Frags	-	1	-	-	-	-	-	-	-
695	EU 154	98.66-98.50	-	3	15.7	Deer	-	Metatarsal	-	Proximal	L	1	1	1	-	-	-	-	weathered surface, spiral fractured
695	EU 154	98.66-98.50	-	1	1.3	Indeterminate	-	Skull	-	Medial	-	1	-	-	-	-	-	-	-
695	EU 154	98.66-98.50	-	1	0.5	Dog/Coyote size	-	1st Phalange	-	Complete	-	1	-	-	-	-	-	-	looks fresh
695	EU 154	98.66-98.50	-	1	1.6	Bison size	-	Tooth	-	Frags	-	1	-	-	-	-	-	-	-
695	EU 154	98.66-98.50	-	4	4.3	Bison size	-	Rib	-	Frags	-	3	1	-	-	-	-	-	-
695	EU 154	98.66-98.50	-	15	5.4	Indeterminate	-	-	-	Frags	-	15	-	-	-	-	-	-	-
696	EU 154	98.50-98.40	-	1	0.4	Indeterminate	-	-	-	Frags	-	1	-	-	-	-	-	-	-
698	EU 155	98.66-98.50	-	1	4.7	Deer	-	Mandible, M3	old	Complete	L	1	-	-	-	-	-	-	-
698	EU 155	98.66-98.50	-	19	12.6	Indeterminate	-	-	-	Frags	-	17	2	-	-	-	4 white	-	-
700	EU 155	98.53	-	14	113.7	Bison size	-	Tibia	-	Medial	-	11	-	-	1	2	-	-	weathered, rodent chewed, spiral fractured
701	EU 155	98.55	-	1	141.9	Bison	-	Humerus	-	Proximal	R	-	-	-	1	-	-	-	all cancellous tissue, weathered
702	EU 156	98.77-98.60	-	1	0.7	Indeterminate	-	-	-	Frags	-	1	-	-	-	-	1 black/ white	-	-
703	EU 156	98.60-98.50	-	10	6.3	Indeterminate	-	-	-	Frags	-	7	3	-	-	-	-	-	-
705	EU 157	98.84-98.70	-	1	0.2	Indeterminate	-	-	-	Frags	-	1	-	-	-	-	-	-	-
706	EU 157	98.70-98.60	-	1	32.5	Bison size	-	Metapodial	-	Proximal	-	-	-	1	-	-	-	-	rodent chewed
706	EU 157	98.70-98.60	-	1	1.3	Deer	-	Tooth	young	Complete	L	1	-	-	-	-	-	-	-
706	EU 157	98.70-98.60	-	1	0.3	Rabbit size	-	Long bone	-	Medial	-	1	-	-	-	-	-	-	-
706	EU 157	98.70-98.60	-	1	0.3	Turtle	-	Carapace	-	Medial	-	1	-	-	-	-	black	-	-

APPENDIX B: Neutron Activation Analysis of Toyah Ceramics from 41HM51, Hamilton County, Texas

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Archaeometry Laboratory

Neutron Activation Analysis of Toyah Ceramics from 41HM51, Hamilton County, Texas (GST238-248):

A comparison to the recent study of over 600 Central Texas ceramics previously analyzed by NAA

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Introduction
This project involves the analysis of 11 Toyah ceramics (GST238-248) from 41HM51 in Hamilton County, Texas. The site includes multiple dated components ranging from 1200-1700 A.D. We have found three distinct groups within the new samples and this report describes the group separation as well as comparison to previously defined groups from Central Texas. A complete list of the samples included in this study, along with compositional group assignments and some basic descriptive information is available in Table 1.

Sample Preparation
Pottery specimens were prepared for INAA using procedures standard at MURR. Fragments of about 1cm^2 were removed from each sample and abraded using a silicon carbide burr in order to remove glaze, slip, paint, and adhering soil, thereby reducing the risk of measuring contamination. The specimens were washed in deionized water and allowed to dry in the laboratory. Once dry, the individual sherds were ground into powders with an agate mortar and pestle to homogenize the samples. Archival samples were retained from each sherd (when possible) for future research.

Two analytical samples were prepared from each source specimen. Portions of approximately 150 mg of powder were weighed into clean high-density polyethylene vials used for short irradiations at MURR. At the same time, 200 mg of each sample was weighed into clean high-purity quartz vials used for long irradiations. Individual sample weights were recorded to the nearest 0.01 mg using an analytical balance. Both vials were sealed prior to irradiation. Along with the unknown samples, Standards made from National Institute of Standards and Technology (NIST) certified standard reference materials of SRM-1633b (coal fly ash) and SRM-688 (basalt rock) were similarly prepared, as were quality control samples (e.g., standards treated as unknowns) of SRM-278 (obsidian rock) and Ohio Red Clay (a quality control developed for in-house applications).

Irradiation and Gamma-Ray Spectroscopy
Neutron activation analysis of ceramics at MURR, which consists of two irradiations and a total of three gamma counts, constitutes a superset of the procedures used at most other NAA laboratories (Glascock 1992; Neff 1992, 2000). As discussed in detail by Glascock (1992), a short irradiation is carried out through the pneumatic tube irradiation system. Samples in the polyvials are sequentially irradiated, two at a time, for five seconds by a neutron flux of 8 x 10^{13} n cm^{-2} s^{-1}. A 720-second count yields gamma spectra containing peaks for nine short-lived elements: aluminum (Al), barium (Ba), calcium (Ca), dysprosium (Dy), potassium (K), manganese (Mn), sodium (Na), titanium (Ti), and vanadium (V). The samples encapsulated in quartz vials are subjected to a 24–hour irradiation at a neutron flux of 5 x 10^{13} n cm^{-2} s^{-1}. This long irradiation is analogous to the single irradiation utilized at most other laboratories. After the long irradiation, samples decay for seven days, and then are counted for 1,800 seconds (the "middle count") on a high-resolution germanium detector coupled to an automatic sample changer. The middle count yields determinations of seven medium half-life elements, namely arsenic (As), lanthanum (La), lutetium (Lu), neodymium (Nd), samarium (Sm), uranium (U), and ytterbium (Yb). After an additional three- or four-week decay, a final count of 8,500 seconds is carried out on each sample. The latter measurement yields the following 17 long half-life

elements: cerium (Ce), cobalt (Co), chromium (Cr), cesium (Cs), europium (Eu), iron (Fe), hafnium (Hf), nickel (Ni), rubidium (Rb), antimony (Sb), scandium (Sc), strontium (Sr), tantalum (Ta), terbium (Tb), thorium (Th), zinc (Zn), and zirconium (Zr).

Interpreting Chemical Data

The analyses at MURR produce concentration values for 33 elements in most samples; however for a number of reasons, the comparative Central Texas database does not include data for Na, Mn, Ni, Ca, and Sr and these data are not included in this analysis. The comparative data includes samples analyzed at Texas A&M following similar procedures and using the same standards as MURR, and thus no transformation of the data was necessary to make it compatible with the MURR data.

All further statistical analysis was carried out on base-10 logarithms of concentrations on the remaining elements. Use of log concentrations rather than raw data compensates for differences in magnitude between the major elements, such as iron, on one hand and trace elements, such as the rare earth or lanthanide elements (REEs). Transformation to base-10 logarithms also yields a more normal distribution for many trace elements.

The interpretation of compositional data obtained from the analysis of archaeological materials is discussed in detail elsewhere (e.g., Baxter and Buck 2000; Bieber et al. 1976; Bishop and Neff 1989; Glascock 1992; Harbottle 1976; Neff 2000) and will only be summarized here. The main goal of data analysis is to identify distinct homogeneous groups within the analytical database. Based on the provenance postulate of Weigand *et al*. (1977), different chemical groups may be assumed to represent geographically restricted sources. For lithic materials such as obsidian, basalt, and cryptocrystalline silicates (e.g., chert, flint, or jasper), raw material samples are frequently collected from known outcrops or secondary deposits and the compositional data obtained on the samples is used to define the source localities or boundaries. The locations of sources can also be inferred by comparing unknown specimens (i.e., ceramic artifacts) to knowns (i.e., clay samples) or by indirect methods such as the "criterion of abundance" (Bishop *et al*. 1992) or by arguments based on geological and sedimentological characteristics (e.g., Steponaitis *et al*. 1996). The ubiquity of ceramic raw materials usually makes it impossible to sample all potential "sources" intensively enough to create groups of knowns to which unknowns can be compared. Lithic sources tend to be more localized and compositionally homogeneous in the case of obsidian or compositionally heterogeneous as is the case for most cherts.

Compositional groups can be viewed as "centers of mass" in the compositional hyperspace described by the measured elemental data. Groups are characterized by the locations of their centroids and the unique relationships (i.e., correlations) between the elements. Decisions about whether to assign a specimen to a particular compositional group are based on the overall probability that the measured concentrations for the specimen could have been obtained from that group.

Initial hypotheses about source-related subgroups in the compositional data can be derived from non-compositional information (e.g., archaeological context, decorative attributes, etc.) or from application of various pattern-recognition techniques to the multivariate chemical data. Some of the pattern recognition techniques that have been used to investigate archaeological data sets are cluster analysis (CA), principal components analysis (PCA), and discriminant analysis (DA). Each of the techniques has it own advantages and disadvantages which may depend upon the types and quantity of data available for interpretation.

The variables (measured elements) in archaeological and geological data sets are often correlated and frequently large in number. This makes handling and interpreting patterns within the data difficult. Therefore, it is often useful to transform the original variables into a smaller set of uncorrelated variables in order to make data interpretation easier. Of the above-mentioned pattern recognition techniques, PCA is a technique that transforms from the data from the original correlated variables into uncorrelated variables most easily.

PCA creates a new set of reference axes arranged in decreasing order of variance subsumed. The individual PCs are linear combinations of the original variables. The data can be displayed on combinations of the new axes, just as they can be displayed on the original elemental concentration axes. PCA can be used in a pure pattern-recognition mode, i.e., to search for subgroups in an undifferentiated data set, or in a more evaluative mode, i.e., to assess the coherence of hypothetical groups suggested by other criteria. Generally, compositional differences between specimens can be expected to be larger for specimens in different groups than for specimens in the same group, and this implies that groups should be detectable as distinct areas of high point density on plots of the first few components.

It is well known that PCA of chemical data is scale dependent (Mardia *et al*. 1979), and analyses tend to be dominated by those elements or isotopes for which the concentrations are relatively large. As a result, standardization methods are common to most statistical packages. A common approach it to transform the data into logarithms (e.g., base 10).

One frequently exploited strength of PCA, discussed by Baxter (1992), Baxter and Buck (2000), and Neff (1994, 2002), is that it can be applied as a simultaneous R- and Q-mode technique, with both variables (elements) and objects (individual analyzed samples) displayed on the same set of principal component reference axes. A plot using the first two principal components as axes is usually the best possible two-dimensional representation of the correlation or variance-covariance structure within the data set. Small angles between the vectors from the origin to variable coordinates indicate strong positive correlation; angles at 90 degrees indicate no correlation; and angles close to 180 degrees indicate strong negative correlation. Likewise, a plot of sample coordinates on these same axes will be the best two-dimensional representation of Euclidean relations among the samples in log-concentration space (if the PCA was based on the variance-covariance matrix) or standardized log-concentration space (if the PCA was based on the correlation matrix). Displaying both objects and variables on the same plot makes it possible to observe the contributions of specific elements to group separation and to the distinctive shapes of the various groups. Such a plot is commonly referred to as a "biplot" in reference to the simultaneous plotting of objects and variables. The variable inter-relationships inferred from a biplot can be verified directly by inspecting bivariate elemental concentration plots. [Note that a bivariate plot of elemental concentrations is not a biplot.]

Whether a group can be discriminated easily from other groups can be evaluated visually in two dimensions or statistically in multiple dimensions. A metric known as the Mahalanobis distance (or generalized distance) makes it possible to describe the separation between groups or between individual samples and groups on multiple dimensions. The Mahalanobis distance of a specimen from a group centroid (Bieber *et al*. 1976, Bishop and Neff 1989) is defined by:

$$D^2_{y,X} = [y - \overline{X}]^t I_x [y - \overline{X}]$$

where y is the 1 x m array of logged elemental concentrations for the specimen of interest, X is the n x m data matrix of logged concentrations for the group to which the point is being compared with $\overline{X}$ being it 1 x m centroid, and I_x is the inverse of the m x m variance-covariance matrix of group X. Because Mahalanobis distance takes into account variances and covariances in the multivariate group it is analogous to expressing distance from a univariate mean in standard deviation units. Like standard deviation units, Mahalanobis distances can be converted into probabilities of group membership for individual specimens. For relatively small sample sizes, it is appropriate to base probabilities on Hotelling's T^2, which is the multivariate extension of the univariate Student's t.

When group sizes are small, Mahalanobis distance-based probabilities can fluctuate dramatically depending upon whether or not each specimen is assumed to be a member of the group to which it is being compared. Harbottle (1976) calls this phenomenon "stretchability" in reference to the tendency of an included specimen to stretch the group in the direction of its own location in elemental concentration space. This problem can be circumvented by cross-validation, that is, by removing each specimen from its presumed group before calculating its own probability of membership (Baxter 1994; Leese and Main 1994). This is a conservative approach to group evaluation that may sometimes exclude true group members.

Small sample and group sizes place further constraints on the use of Mahalanobis distance: with more elements than samples, the group variance-covariance matrix is singular thus rendering calculation of I_x (and D^2 itself) impossible. Therefore, the dimensionality of the groups must somehow be reduced. One approach would be to eliminate elements considered irrelevant or redundant. The problem with this approach is that the investigator's preconceptions about which elements should be discriminate may not be valid. It also squanders the main advantage of multielement analysis, namely the capability to measure a large number of elements. An alternative approach is to calculate Mahalanobis distances with the scores on principal components extracted from the variance-covariance or correlation matrix for the complete data set. This approach entails only the assumption, entirely reasonable in light of the above discussion of PCA, that most group-separating differences should be visible on the first several PCs. Unless a data set is extremely complex, containing numerous distinct groups, using enough components to subsume at least 90% of the total variance in the data can be generally assumed to yield Mahalanobis distances that approximate Mahalanobis distances in full elemental concentration space.

Lastly, Mahalanobis distance calculations are also quite useful for handling missing data (Sayre 1975). When many specimens are analyzed for a large number of elements, it is almost certain that a few element concentrations will be missed for some of the specimens. This occurs most frequently when the concentration for an element is near the detection limit. Rather than eliminate the specimen or the element from consideration, it is possible to substitute a missing value by replacing it with a value that minimizes the Mahalanobis distance for the specimen from the group centroid. Thus, those few specimens which are missing a single concentration value can still be used in group calculations.

Results and Conclusions

The new ceramic samples are assigned to three chemically distinct groups, with no unassigned samples. We first present these internal groupings before comparing the new data to the broader Central Texas Database (Creel et al. 2013).

Internal Groups:

The three groups were identified in bivariate plots (Figure 1) and were supported with a hierarchical cluster analysis (Figure 2).

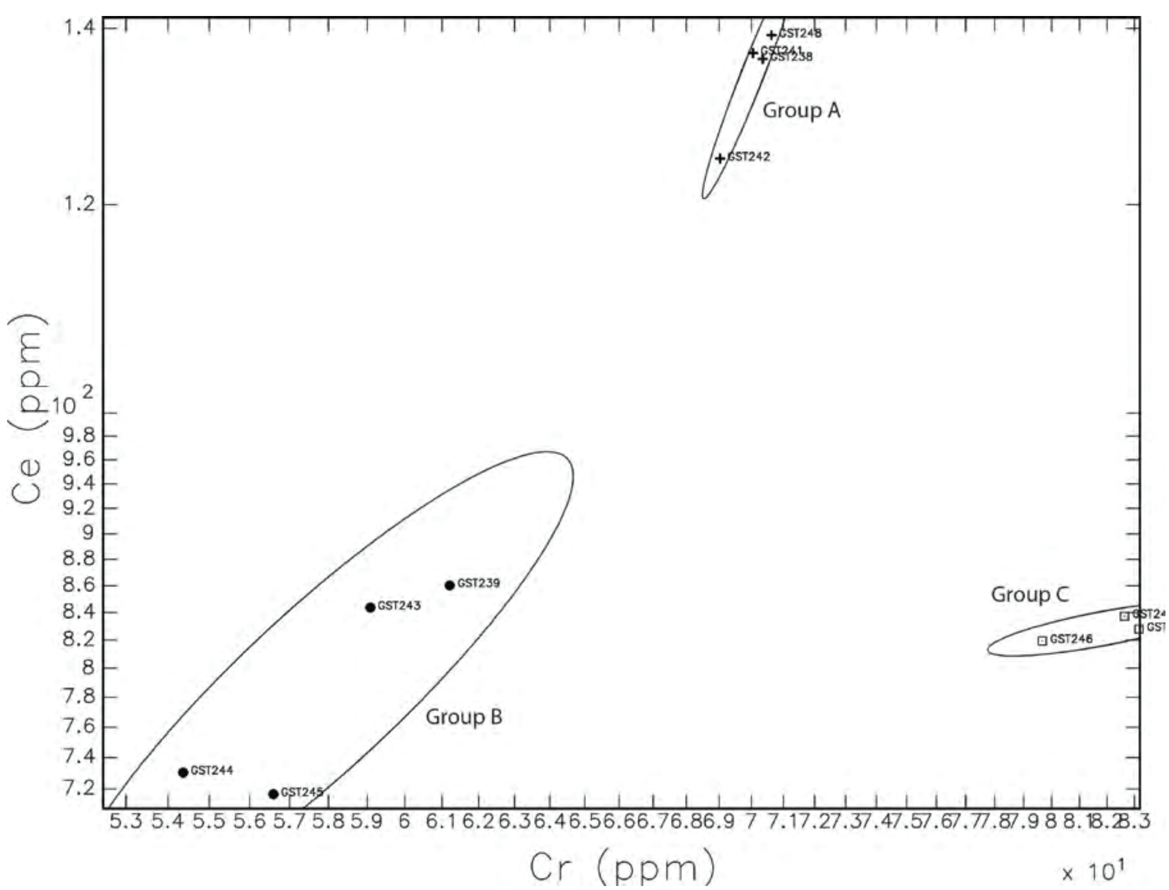

Figure 1: Bivariate plot of chromium and cerium (log base-10 ppm) showing the three internal groups. Ellipses represent 90% confidence intervals for membership in the groups.

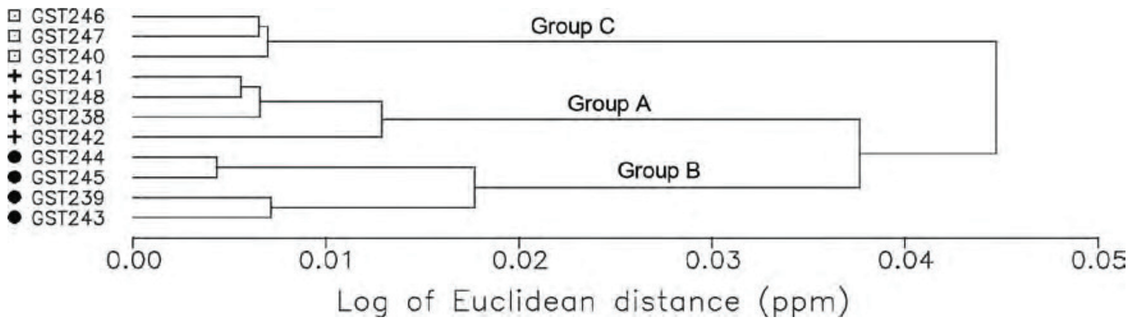

Figure 2: Hierarchical cluster analysis of the new samples.

Such clear separation (as shown in Figures 1 and 2) is uncommon in small studies of prehistoric ceramics. There is no clear correlation between any of the descriptive information provided and compositional group assignment. The samples were all recovered from the same site and there is no differentiation between the samples except for the exterior decoration. It would be very interesting to see if the same group structure would be found using petrographic analysis. Given the distinct separation between the groups it would seem reasonable that the ceramics were imported from at least three different locations with compositionally distinct raw materials. Our comparison of the new samples to the Central Texas reference groups is presented below.

<u>Central Texas Reference Group Comparison:</u>
The Central Texas reference groups were developed in 2013 by a joint effort involving Darrell Creel, Doug Boyd, and Jeff Ferguson, and the results of this analysis are presented in a 2013 publication by Creel et al. The database includes over 600 sherds from Central Texas assigned to 15 compositionally distinct groups. Creel made an effort to remove any apparent Caddo ceramics from the database prior to developing the groups. Each of the three groups identified in this current study are individually compared to the Central Texas reference groups. The minimal overlap with the established reference groups might be in part due to the lack of samples from the region around 41HM51. The database does not include any previously analyzed samples from within a roughly 70km radius of the site.

Group A
The four specimens in Group A separate from all of the reference groups as shown in Figure 3 except for Group 15. The samples differentiate from Group 15 in numerous other bivariate plots.

Group B
The Group B specimens show an interesting pattern. They are most similar to Groups 10 and 11, with a slightly stronger match with Group 11. Group 11 is one of the three major groups in Central Texas, but the majority of the members of this group are from sites closer to the Gulf Coast and south of the Guadalupe River (Creel et al. 2013: Figure 24). There is another small cluster in Group 11 from a site approximately 150 km east of 41HM51. Whether these represent a small locally-made paste recipe that is compositionally similar to Group 11 or are traded items from far to the south is not clear. Figure 4 shows the samples relative to Groups 10 and 11.

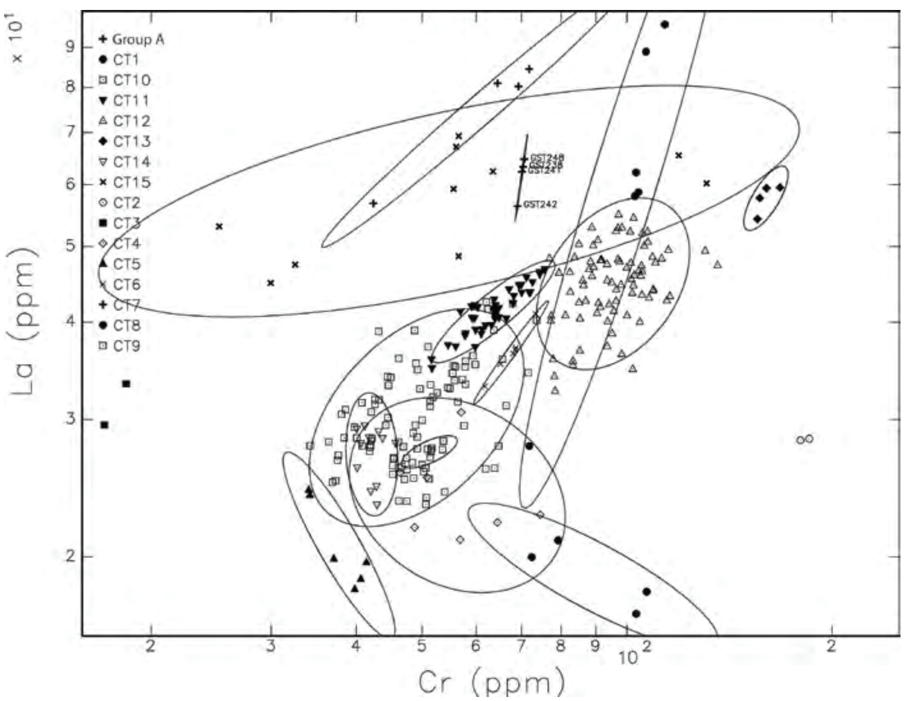

Figure 3: Bivariate plot of chromium and lanthanum (log base-10 ppm) showing the relationship between Groups A and the Central Texas Reference Groups. Only the Group A members are labeled. Ellipses represent 90% confidence intervals group membership.

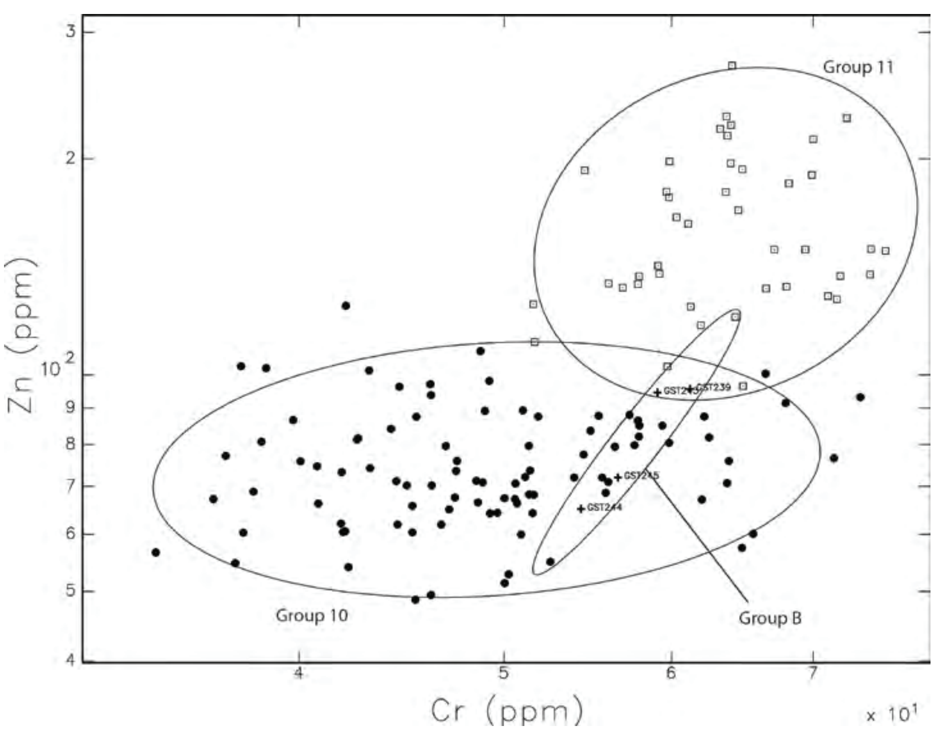

Figure 4: Bivariate plot of chromium and zinc (log base-10 ppm) showing the relationship between Group B and the Central Texas Reference Groups 10 and 11. Ellipses represent 90% confidence intervals group membership.

Group C

Group C is the most compositionally uniform of the three new groups. Figure 5 shows the separation of Group C from all of the Central Texas Reference Groups except for Group 8, but many other plots show a clear separation from Group 8.

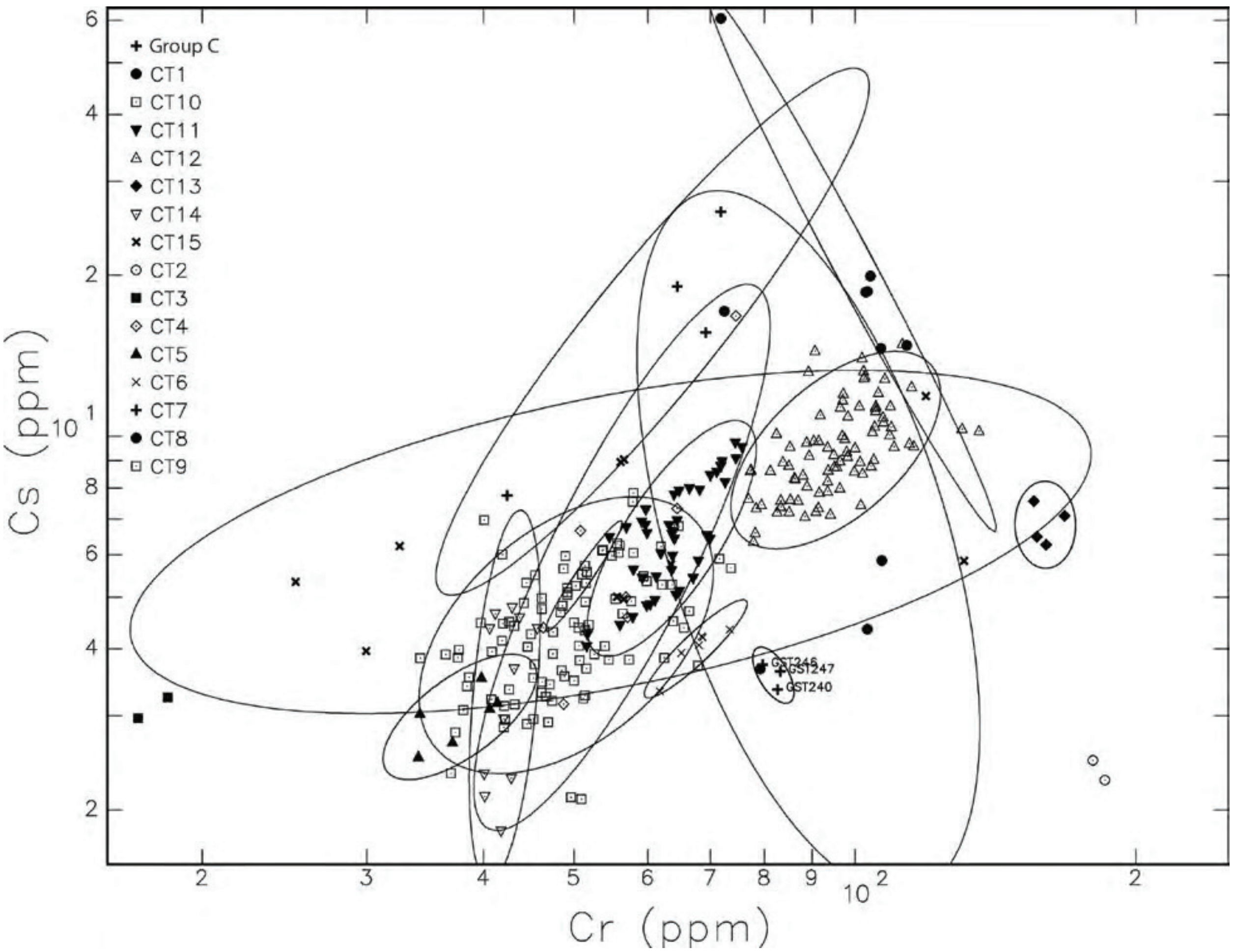

Figure 3: Bivariate plot of chromium and cesium (log base-10 ppm) showing the relationship between Group C and the Central Texas Reference Groups. Only the Group C members are labeled. Ellipses represent 90% confidence intervals group membership.

Comparison to Unassigned Specimens

If the three groups identified in this study (with the possible exception of Group B) represent new groups from Central Texas, then it is possible that previously unassigned samples may fall into these groups. The Central Texas Database includes 161 unassigned specimens and 17 outlier specimens. A hierarchical cluster analysis reveals that the three groups remain distinct with none of the unassigned or outlier specimens revealing a similar chemistry.

Conclusions:
The analysis of 11 Toyah ceramics from 41HM51 revealed three chemically-distinct groups of samples. These groups exhibit high internal chemical uniformity. Clustering this tight is a rare occurrence, especially in a region such as Central Texas which typically included great variability and relatively "fuzzy" groups. We are interested in seeing the results of the petrographic analysis to examine a number of possible explanations, one of which would include the analysis of multiple fragments from the same vessel(s).

This new sample fills a geographic void in the Central Texas NAA database, but raises more questions than it answers as to ceramic production in the region. Even if these ceramics were imported from surrounding regions (which would help explain the variability), the lack of variability within the three groups is uncharacteristic of the ceramic assemblages in the broader region. Only one of the three new groups fits well with any of the 15 established Central Texas Reference Groups, yet the scale of variability within Group B is inconsistent with the greater variability seen in both Groups 10 and 11. Additional samples from this site and other sites in the area may help to understand ceramic production and movement in the region.

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Table 1: Descriptive information and group assignments for all new samples included in this study.

ANID	Compositional Group	Alternate ID	Vessel Form	Exterior Decoration
GST238	A	175	body sherd	brushed and incised
GST239	B	364	neck sherd	plain
GST240	C	304	body sherd	linear applique
GST241	A	386	body sherd	brushed
GST242	A	125-1	base sherd	undecorated
GST243	B	613	rim sherd	plain
GST244	B	118	body sherd	brushed
GST245	B	130	rim sherd	finger nail punctated
GST246	C	589	body sherd	applique
GST247	C	515	body sherd	incized
GST248	A	196	rim sherd	incized

APPENDIX C: Petrographic Analysis of Pottery Sherds from 41HM51

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Petrographic Analysis of Pottery Sherds from 41HM51

Lori Barkwill-Love

This technical report summarizes the result of the petrographic analysis of a sample of 11 specimens excavated by Prewitt and Associates Inc., from 41HM51. The excavations were sponsored by the Texas Department of Transportation.

Methods

The thin sections were examined with a Motic Petrographic microscope with an attached mechanical stage. A two-step process was used to examine the thin sections. The first step involved recording their general characteristics and taking photomicrographs of the thin sections. The general characteristics recorded were paste matrix descriptions, paste color, b- fabric (Stoops 2003:95), and description of edges. For the photomicrographs, at least one set (plane light and cross-polar light) were taken of each thin section at 4x. Digital images were captured using an Infinity 3-3 Digital Camera attached to a computer.

The second step involved point counting using the Glagolev-Chayes method. The Glagolev-Chayes method involves using the mechanical stage, which allows one to move the thin section at a given interval beneath the crosshairs in the ocular, and identifying and recording each point encountered in the crosshairs. For the point count sampling, the microscope was set at 10x magnification, and the stage was set so that the vertical and horizontal increments were both 0.5 mm. Each point encountered was identified as paste matrix, void, or non-plastic inclusion. Paste matrix was recorded by tally; however, for all voids and non-plastic inclusions, estimated size and shape were recorded. Non-plastic inclusions and voids were only counted once even if they were encountered more than once in the crosshairs. Once the point counting was completed, non-plastic inclusions that were encountered but not included in the point counting were recorded with a general estimate of their frequency.

The thin sections were point counted until 200 paste points were reached. Stoltman (1989:151-152, 2012:H-1) suggests that a minimum of 100 points (exclusive of voids) are needed to ensure reliable results and that point counting in excess of 200 points yields redundancy. Therefore, point counting until 200 paste points are reached should yield reliable results. With 200 paste points counted, the minimum number of points recorded was 243, and the maximum number of points recorded was 296. The counts, measurements and paste, voids, and non-plastic inclusion type recorded during point counting for each thin section were input into a JMP Pro 10 data table.

The size of the non-plastic inclusion or void was based on the maximum diameter of the inclusion/void measured with the ocular scale to the nearest whole number. At 10x magnification, each tick mark on the ocular scale represents 0.01 mm. The raw tick mark count was recorded for each inclusion, input into JMP and converted to an actual size.

Temper Categories

To assign temper categories to thin-sections, the recorded paste/inclusions were combined into the following simplified categories:

Recorded Paste/Inclusion	Simplified Inclusion Category
Paste	Paste Bone
Bone Quartz	Sand
Polycrystalline quartz	Sand Alkali
feldspar	Sand Chert
Sand Rock conglomerate	Sand
Perthite	Sand
Plagioclase	Sand
Muscovite	Mica Grog
Grog Clay Pellet	Grog
Shell	Shell Opaque/Hematite
Other	
Voids	Not included

A frequency distribution was created for each sherd based on the simplified inclusion category (voids excluded) to determine temper categories. The “other” category was not used in temper assignments given that this category made up less than 5% of the inclusion categories. Opaques are likely hematite. Clay pellets were all solid black with sand inclusions (except in sample 364-3 in which the clay pellets were reddish-black with sand inclusions). It is unknown whether these clay pellets were some form of hematite or burnt crushed sherds that had been added as temper; therefore, they were classified as grog. All the sherds from 41HM51 were grog tempered; however there were differences in the paste and other inclusions.

Thin Section Descriptions

Sample ID: 41HM51-118-8
Temper: Grog
Paste Matrix: Continuous – 10YR 3/6 Dark Yellowish Brown
B-Fabric: Undifferentiated
Inclusion Orientation to Rim: Moderately parallel
Mica Present: Rare
Carbonates Present:
None Hematite Present:
Rare
Temper found in grog: Sand, bone

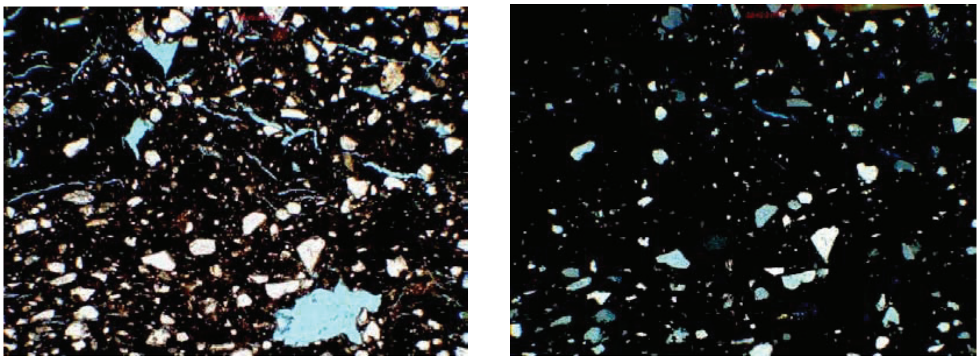


Figure C.1. Plain light (L) and cross-polar (R) light micrograph; 41HM51-118-8.

Point Counts

Paste/Inclusion	Count	Frequency	Simplified Categories	Count	Frequency
Paste	200	77.82%	Paste	200	81.63%
Quartz	28	10.89%	Sand	41	16.73%
Grog	3	1.17%	Grog	3	1.22%
Polycrystalline quartz	5	1.95%	Other	1	0.41%
Alkali feldspar	6	2.33%	**Total**	**245**	
Opaque	1	0.39%			
Chert	2	0.78%			
Voids	12	4.67%			
Total	**257**				

Present but not encountered: plagioclase (rare), clay pellet (uncommon)

Percentage of sand greater than silt size:
68.29% Percentage of angular sand grains:
48.78%

Inclusion Size (mm)

	Range	Mean	Median	Interquartile Range
Sand	.02 – .40	.13	.11	.12
Grog	.92 – 1.87	1.28	1.05	.95
All Non-plastics	.02 – 1.87	.20	.13	.13

Sample ID: 41HM51-125-1-6
Temper: Grog
Paste Matrix: Continuous – 10YR 5/6 Yellowish Brown – Core slightly lighter than edges – Edges 10YR 4/6 Dark Yellowish Brown
B-Fabric: Speckled-Slightly Active
Inclusion Orientation to Rim:
Random Mica Present: Rare
Carbonates: Rare
(shell) Hematite:

Common
Temper found in grog: sand, bone
Comments: Very porous, bone and shell are rare but only bone found in grog – shell may be natural inclusion in clay

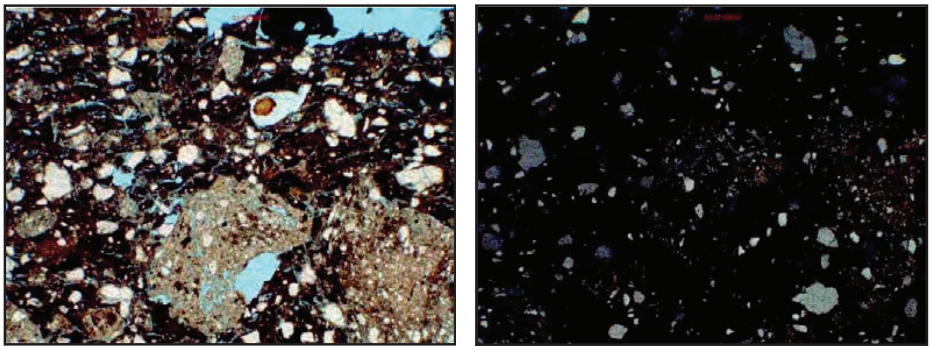


Figure C.2. Plain light (L) and cross-polar (R) light micrograph; 41HM51-125-1-6.

Point Counts

Paste/Inclusion	**Count**	**Frequency**	**Simplified Categories**	**Count**	**Frequency**
Paste	200	68.03%	Paste	200	75.76%
Quartz	28	9.52%	Sand	32	12.12%
Grog	20	6.80%	Shell	1	0.38%
Shell	1	0.34%	Grog	27	10.23%
Polycrystalline quartz	2	0.68%	Other	4	1.52%
Alkali feldspar	1	0.34%	**Total**	**264**	
Clay pellet	7	2.38%			
Opaque	4	1.36%			
Rock conglomerate	1	0.34%			
Voids	30	10.20%			
Total	**294**				

Present but not encountered: Bone (rare), microcline (rare), mafic (rare), chert (uncommon), hornblende (rare)

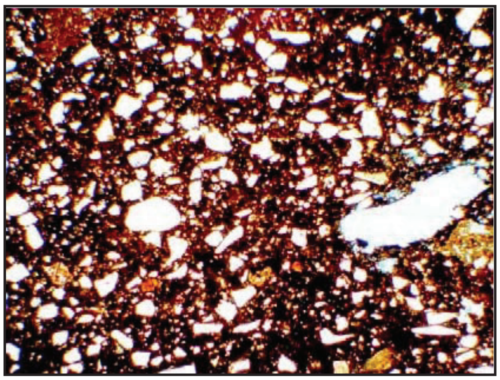
Percentage of sand greater than silt size: 75.00%
Percentage of angular sand grains: 34.38%

Inclusion Size (mm)

	Range	**Mean**	**Median**	**Interquartile Range**
Sand	.03 – .29	.11	.11	.09
Grog	.15 – 1.97	.61	.54	.31
All Non-plastics	.03 – 1.97	.33	.17	.40

Sample ID: 41HM51-130-9

Temper: Grog
Paste Matrix: Continuous – 10YR 4/6 Dark Yellowish Brown
B-Fabric: Undifferentiated
Inclusion orientation to rim: Moderately parallel
Mica Present: Uncommon
Carbonates Present: None
Hematite Present: Uncommon
Temper found in grog: sand



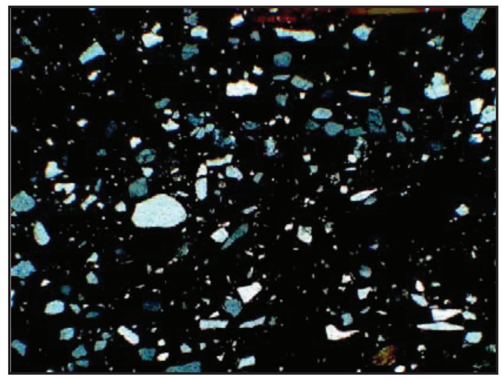


Figure C.3. Plain light (L) and cross-polar (R) light micrograph; 41HM51-130-9.

Point Counts

Paste/Inclusion	**Count**	**Frequency**	**Simplified Categories**	**Count**	**Frequency**
Paste	200	76.34%	Paste	200	76.92%
Quartz	34	12.98%	Sand	55	21.15%
Grog	3	1.15%	Grog	4	1.54%
Polycrystalline quartz	7	2.67%	Other	1	0.38%
Alkali feldspar	7	2.67%	**Total**	**260**	
Clay pellet	1	0.38%			
Opaque	1	0.38%			
Chert	5	1.91%			
Rock conglomerate	2	0.76%			
Voids	2	0.76%			
Total	**262**				

Present but not encountered: microcline (rare), plagioclase (uncommon), hornblende (rare)

Percentage of sand greater than silt size: 72.73%
Percentage of angular sand grains: 54.55%

Inclusion Size (mm)

	Range	**Mean**	**Median**	**Interquartile Range**
Sand	.02 – .47	.13	.10	.13

Grog	.29 – 1.04	.68	.70	.64
All Non-plastics	.02 – 1.04	.17	.11	.13

Sample ID: 41HM51-175-1
Temper: Grog and possible bone
Paste Matrix: Continuous – 10YR 3/3 Dark Brown – Core slightly lighter – Edges 10YR 2/2 Very Dark Brown
B-Fabric: Undifferentiated
Inclusion Orientation to Rim: Random
Mica Present: Uncommon
Carbonates Present: None
Hematite Present: Uncommon
Temper found in grog: sand, bone (rare)
Comments: Very porous, bone is rare and maybe from grog, but some pieces are large

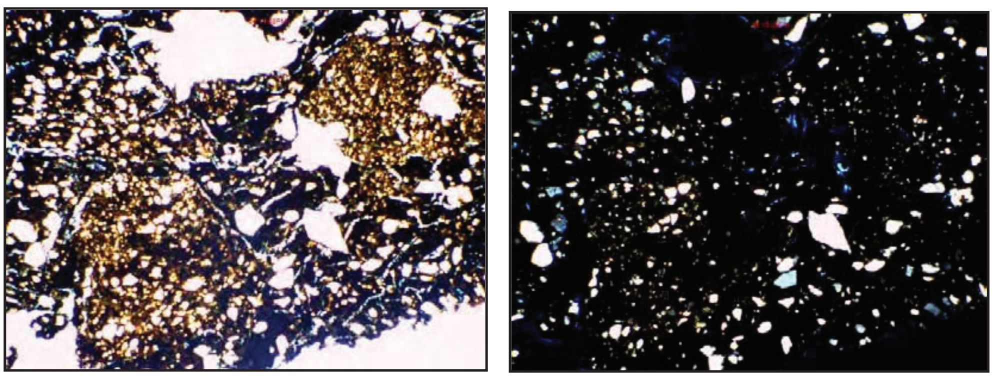


Figure C.4. Plain light (L) and cross-polar (R) light micrograph; 41HM51-175-1.

Point Counts

Paste/Inclusion	**Count**	**Frequency**	**Simplified Categories**	**Count**	**Frequency**
Paste	200	74.35%	Paste	200	80.65%
Quartz	33	12.27%	Sand	40	16.13%
Grog	7	2.60%	Bone	1	0.40%
Bone	1	0.37%	Grog	7	2.82%
Alkali feldspar	6	2.23%	**Total**	**248**	
Plagioclase	1	0.37%			
Voids	21	7.81%			
Total	**269**				

Present but not encountered: chert (common), microcline (uncommon), polycrystalline quartz (uncommon)

Percentage of sand greater than silt size: 72.50%
Percentage of angular sand grains: 35%

Inclusion Size (mm)

	Range	Mean	Median	Interquartile Range
Sand	.02 – .31	.11	.11	.11
Grog	.26 – 1.75	.83	.67	.84
All Non-plastics	.02 – 1.75	.22	.13	.14

Sample ID: 41HM51-196-12
Temper: Grog
Paste Matrix: Continuous – 7.5YR 4/4 Brown
B-fabric: Speckled-Slightly Active
Inclusion Orientation to Rim: Moderately Parallel
Mica Present: Rare
Carbonates Present: None
Hematite Present: Common
Temper found in grog: sand, bone, grog
Comments: bone in paste likely from grog

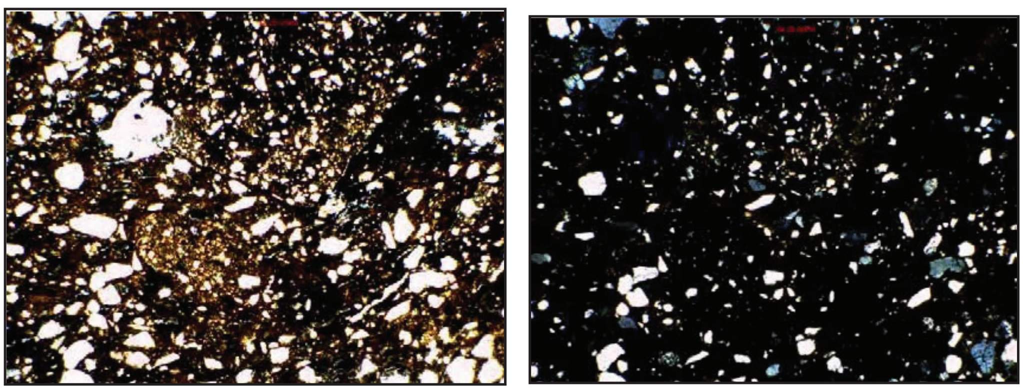


Figure C.5. Plain light (L) and cross-polar (R) light micrograph; 41HM51-196-12.

Point Counts

Paste/Inclusion	**Count**	**Frequency**	**Simplified Categories**	**Count**	**Frequency**
Paste	200	67.57%	Paste	200	70.42%
Quartz	38	12.84%	Sand	57	20.07%
Grog	18	6.08%	Bone	1	0.35%
Bone	1	0.34%	Grog	23	8.10%
Polycrystalline quartz	5	1.69%	Other	3	1.06%
Alkali feldspar	11	3.72%	**Total**	**284**	
Clay pellet	5	1.69%			
Opaque	3	1.01%			
Chert	1	0.34%			
Perthite	1	0.34%			
Rock conglomerate	1	0.34%			

Voids	12	4.05%			
Total	**296**				

Present but not encountered: microcline (rare), mafic (rare)

Percentage of sand larger than silt size: 66.67%
Percentage of angular sand grains: 26.32%

Inclusion Size (mm)

	Range	Mean	Median	Interquartile Range
Sand	.02 – .32	.12	.10	.13
Grog	.17 – 2.02	.87	.85	.85
All Non-plastics	.02 – 2.02	.33	.17	.25

Sample ID: 41HM51-304-4
Temper: Grog
Paste Matrix: Continuous – 10YR 3/4 Dark Yellowish Brown
B-fabric: Undifferentiated
Inclusion Orientation to Rim: Random
Mica Present: Common
Carbonates Present: Uncommon (secondary calcite in spots along edges and in some voids)
Hematite Present: Common
Temper found in grog: sand

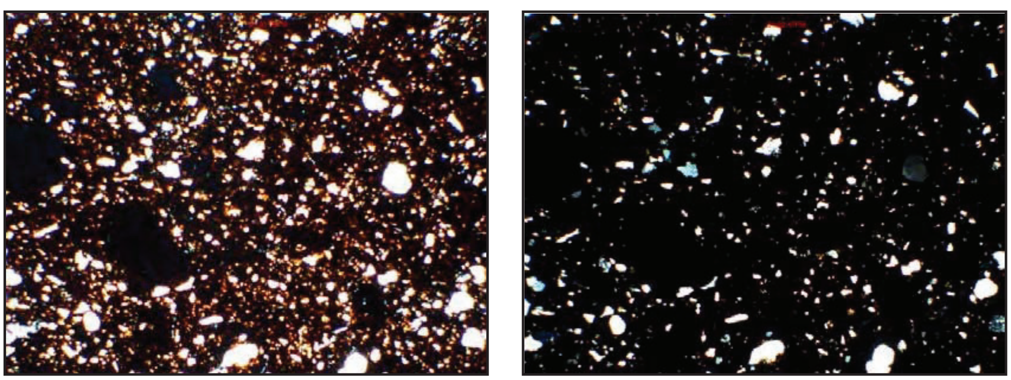


Figure C.6. Plain light (L) and cross-polar (R) light micrograph; 41HM51-304-4.

Point Counts

Paste/Inclusion	Count	Frequency	Simplified Categories	Count	Frequency
Paste	200	78.13%	Paste	200	79.05%
Quartz	35	13.67%	Sand	40	15.81%
Grog	1	0.39%	Grog	12	4.74%
Alkali feldspar	5	1.95%	Mica	1	0.40%
Muscovite	1	0.39%	**Total**	**253**	
Clay pellet	11	4.30%			

Voids	3	1.17%			
Total	**256**				

Present but not encountered: polycrystalline quartz (uncommon), chert (uncommon), mafic (rare), perthite (rare)

Percentage of sand greater than silt size: 27.50%
Percentage of angular sand grains: 10.00%

Inclusion Size (mm)

	Range	Mean	Median	Interquartile Range
Sand	.02 – .30	.07	.04	.04
Grog	.15 – .86	.43	.41	.23
All Non-plastics	.02 – .86	.15	.06	.16

Sample ID: 41HM51-364-3
Temper: Grog
Paste Matrix: Mottled – 2.5Y 7/4 Pale Yellow and 2.5Y 5/6 Light Olive Brown
B-fabric: Speckled/Striated – Active – lighter paste striated – darker paste speckled
Mica Present: Rare Carbonates
Present: None Hematite Present
– Abundant Temper found in
grog: sand
Comments: thin section ground too thin – clay pellets were reddish brown with sand inclusions

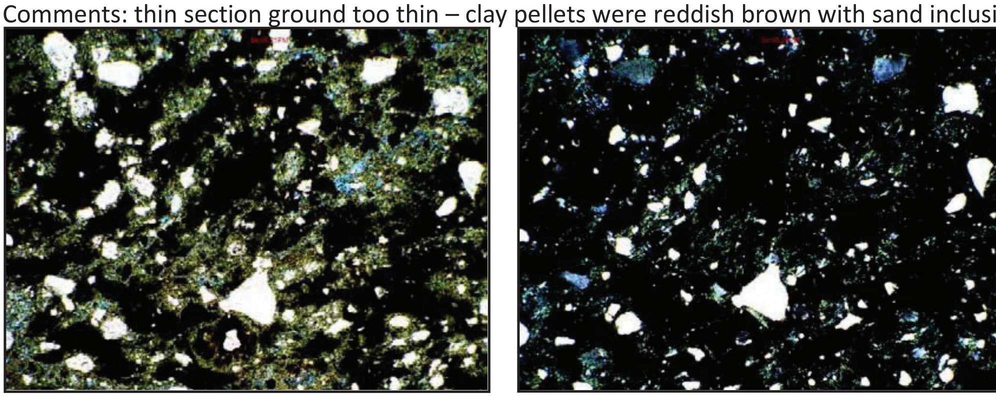


Figure C.7. Plain light (L) and cross-polar (R) light micrograph; 41HM51-364-3.

Point Counts

Paste/Inclusion	Count	Frequency	Simplified Categories	Count	Frequency
Paste	200	80.30%	Paste	200	82.99%
Quartz	20	8.23%	Sand	29	12.03%
Grog	1	0.41%	Grog	4	1.66%
Alkali feldspar	6	2.47%	Other	8	3.32%
Clay pellet	3	1.23%	**Total**	**241**	
Hematite	8	3.29%			
Chert	3	1.23%			

Voids	2	0.82%			
Total	**243**				

Present but not encountered: microcline (rare), polycrystalline quartz (uncommon), mafic (rare)

Percentage of sand grains larger than silt size: 68.97%
Percentage of angular sand grains: 17.24%

Inclusion Size (mm)

	Range	Mean	Median	Interquartile Range
Sand	.02 – .43	.12	.09	.09
Grog	.30 – .95	.53	.43	.55
All Non-plastics	.02 – .95	.18	.13	.20

Sample ID: 41HM51-386-5
Temper: Grog
Paste Matrix: Continuous: 10YR 3/3 Dark Brown
B-fabric: Undifferentiated
Inclusion Orientation to Rim: Random
Mica Present: Rare
Carbonates Present: None
Hematite Present: Rare
Temper found in grog: sand

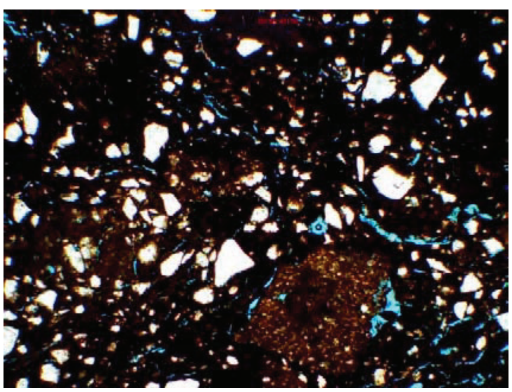
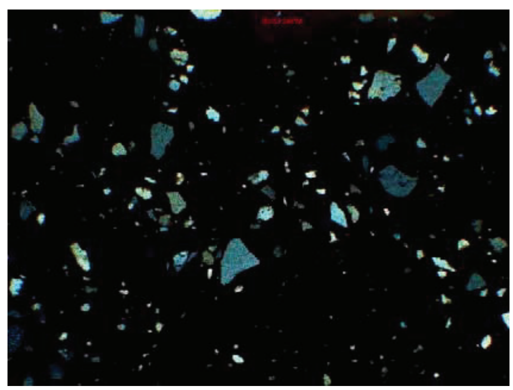



Figure C.8. Plain light (L) and cross-polar (R) light micrograph; 41HM51-386-5.

Point Counts

Paste/Inclusion	Count	Frequency	Simplified Categories	Count	Frequency
Paste	200	77.52%	Paste	200	79.05%
Quartz	29	11.24%	Sand	44	17.39%
Grog	7	2.71%	Grog	9	3.56%
Polycrystalline quartz	3	1.16%	**Total**	**253**	
Alkali feldspar	10	3.88%			

Clay pellet	2	0.78%			
Chert	1	0.39%			
Rock conglomerate	1	0.39%			
Voids	5	1.94%			
Total	**258**				

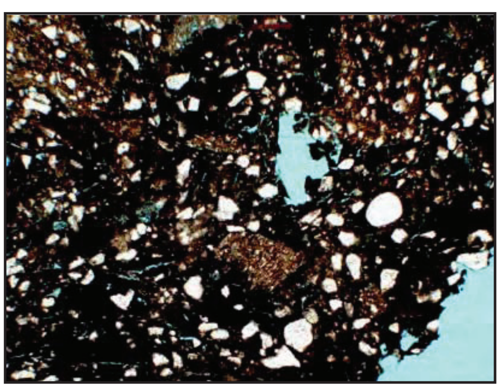
Present but not encountered: chalcedony (rare), perthite (rare), hornblende (rare)

Percentage of sand greater than silt size: 72.73%
Percentage of angular sand grains: 45.45%

Inclusion Size (mm)

	Range	Mean	Median	Interquartile Range
Sand	.03 – .30	.12	.11	.09
Grog	.26 – 2.0	.90	.77	1.10
All Non-plastics	.03 – 2.0	.25	.13	.15

Sample ID: 41HM51-515-11
Temper: Grog
Paste Matrix: Continuous – 10YR 4/6 Dark Yellowish Brown
B-fabric: Undifferentiated
Inclusion Orientation to Rim: Moderately Parallel
Mica Present: Rare Carbonates
Present: None Hematite Present:
Common Temper found in grog::
sand, bone
Comments: Bone likely from grog as it is very small in paste – several different pastes are present for grog



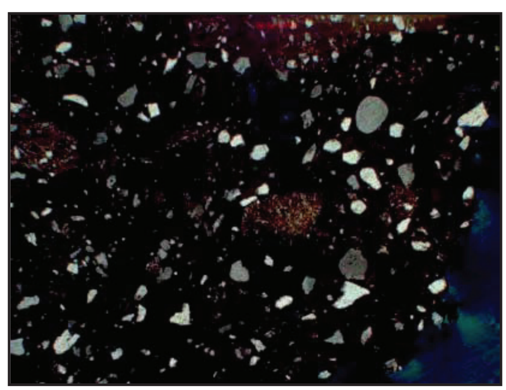


Figure C.9. Plain light (L) and cross-polar (R) light micrograph; 41HM51-515-11.

Point Counts

Paste/Inclusion	Count	Frequency	Simplified Categories	Count	Frequency
Paste	200	69.69%	Paste	200	74.63%
Quartz	33	11.50%	Sand	46	17.16%
Grog	15	5.23%	Grog	20	7.46%
Polycrystalline quartz	5	1.74%	Other	2	0.75%
Alkali feldspar	7	2.44%	**Total**	**268**	
Clay pellet	5	1.74%			
Opaque	2	0.70%			
Chert	1	0.35%			
Voids	19	6.62%			
Total	**287**				

Present but not encountered: bone (rare), mafic (rare), microcline (rare), perthite (uncommon)

Percentage of sand greater than silt size: 73.91%
Percentage of angular sand grains: 23.91%

Inclusion Size (mm)

	Range	Mean	Median	Interquartile Range
Sand	.02 – .25	.11	.11	.10
Grog	.13 – 1.33	.61	.54	.38
All Non-plastics	.02 – 1.33	.26	.14	.25

Sample ID: 41HM51-589-10
Temper: Grog
Paste Matrix: Continuous – 7.5YR 4/4 Brown
B-fabric: Undifferentiated
Inclusion Orientation to Rim: Random
Mica Present: Abundant
Carbonates Present: Rare (secondary calcite in spots along edge and in some voids)
Hematite Present: Abundant
Temper found in grog: sand, grog

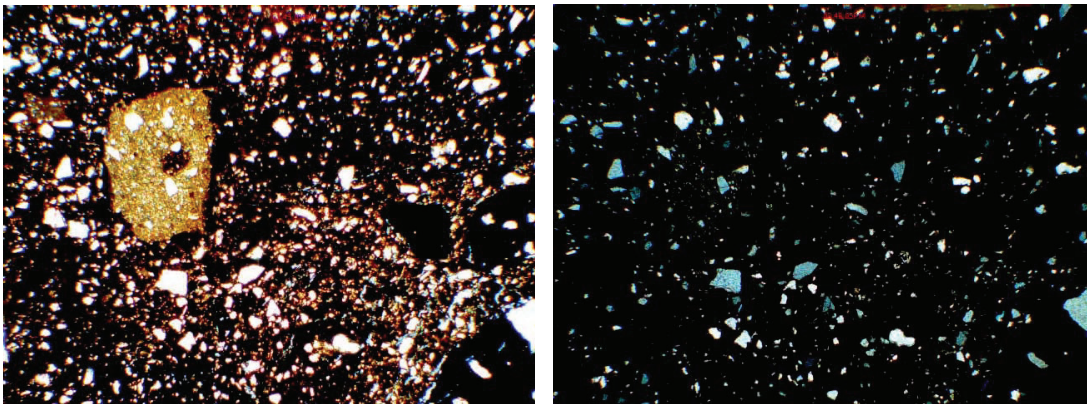


Figure C.10. Plain light (L) and cross-polar (R) light micrograph; 41HM51-589-10.

Point Counts

Paste/Inclusion	**Count**	**Frequency**	**Simplified Categories**	**Count**	**Frequency**
Paste	200	75.19%	Paste	200	77.82%
Quartz	31	11.65%	Sand	37	14.40%
Grog	6	2.26%	Grog	11	4.28%
Alkali feldspar	6	2.26%	Mica	3	1.17%
Muscovite	3	1.13%	Other	6	2.33%
Clay pellet	5	1.88%	**Total**	**257**	
Opaque	6	2.26%			
Voids	9	3.38%			
Total	**266**				

Present but not encountered: polycrystalline quartz (common), microcline (rare), chert (uncommon), mafic (rare)

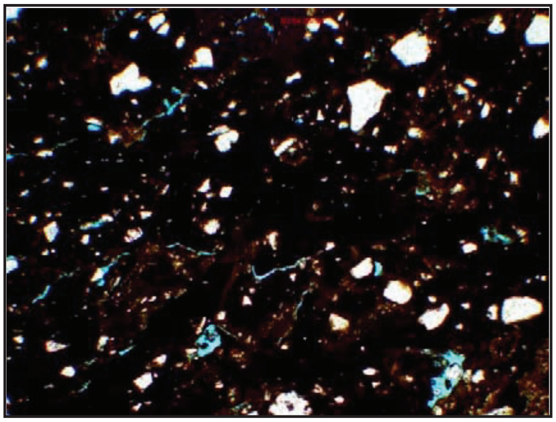
Percentage of sand greater than silt size: 51.35%
Percentage of angular sand grains: 27.03%

Inclusion Size (mm)

	Range	**Mean**	**Median**	**Interquartile Range**
Sand	.02 – .47	.09	.07	.07
Grog	.24 – 3.33	.91	.67	.40
All Non-plastics	.02 – 3.33	.27	.08	.30

Sample ID: 41HM51-613-7
Temper: Grog
Paste Matrix: Slightly Mottled – 7.5YR 2.5/2 Very Dark Brown with spots of 7.5YR 4/6 Strong Brown
B-fabric: Speckled-Slightly Active
Inclusion Orientation to Rim: Random
Mica Present: Rare
Carbonates Present: None

Hematite Present: Common
Temper found in grog: sand



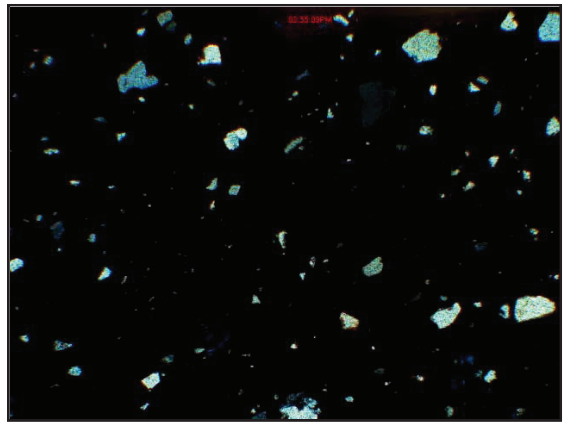


Figure C.11. Plain light (L) and cross-polar (R) light micrograph; 41HM51-613-7.

Point Counts

Paste/Inclusion	**Count**	**Frequency**	**Simplified Categories**	**Count**	**Frequency**
Paste	200	81.30%	Paste	200	84.03%
Quartz	21	8.54%	Sand	33	13.87%
Grog	5	2.03%	Grog	5	2.10%
Polycrystalline quartz	3	1.22%	**Total**	**238**	
Alkali feldspar	7	2.85%			
Chert	1	0.41%			
Rock Conglomerate	1	0.41%			
Voids	8	3.25%			
Total	**246**				

Present but not encountered: N/A

Percentage of sand greater than silt size: 72.73%
Percentage of angular sand grains: 18.18%

Inclusion Size (mm)

	Range	**Mean**	**Median**	**Interquartile Range**
Sand	.03 – .49	.15	.13	.15
Grog	.22 – .63	.44	.42	.24
All Non-plastics	.03 – .63	.19	.14	.20

Summary of Petrographic Analysis Results

All sherds in this sample were tempered with grog, although there were variations in paste and other inclusions that allowed for placing the sherds into two groups with six samples being unassigned to a group.

Table C.1. Petrographic Summary.

	Sherd ID	Sand %	Grog %	Bone Present	Shell Present	Hematite Present	Mica Present	Sand greater than silt	Angular sand grains
Group 1	41HM51-118-8	16.13%	1.22%	Y	N	U	U	68.29%	48.78%
	41HM51-130-9	21.15%	1.54%	N	N	U	U	72.73%	54.55%
	41HM51-386-5	17.39%	3.56%	N	N	U	U	72.73%	45.45%
Group 2	41HM51-196-12	20.07%	8.10%	Y	N	C	U	66.67%	26.32%
	41HM5-515-11	17.16%	7.46%	Y	N	C	U	73.91%	23.91%
Unassigned	41HM51-304-4	15.81%	4.74%*	N	N	C	C	27.50%	10.00%
	41HM51-589-10	14.40%	4.28%*	N	N	C	C	51.35%	27.03%
	41HM51-125-1-6	12.12%	10.23%	Y	Y	C	U	75.00%	34.38%
	41HM51-175-1	16.13%	2.82%	Y	N	U	U	72.50%	35.00%
	41HM51-364-3	12.03%	1.66%*	N	N	C	U	68.97%	17.24%
	41HM51-613-7	13.87%	2.10%	N	N	C	U	72.73%	18.18%

Table key: * = clay pellets make up the majority of the grog – U = uncommon – C = Common

Group 1 consisted of samples 118-8, 130-9, and 386-5. Group 1 consisted of a sandy paste with little grog added. The majority of the sand was greater than silt size with angular grains common. Quartzite (polycrystalline quartz and chert) and feldspars were common inclusions in the sand. Hematite (opaques) and mica were uncommon in group 1. In general the paste matrix was dark brown in color in plane light and undifferentiated in cross-polar light.

Group 2 consisted of samples 515-11 and 196-12. Group 2 consisted of a sandy paste with a moderate amount of grog temper. The majority of the sand was greater than silt size with rounded grains common. Quartzite and feldspars were common inclusions in the sand. Hematite was common; however, mica was uncommon. Bone was found in the paste of both of these sherds; however, given that bone was rare and generally very small, it was likely from the bone-tempered grog that had been added to the clay.

The remaining six sherds were considered unique and could not be assigned to a group. Although samples 304-4 and 589-10 had similar percentages of sand and grog, 304-4 had mostly silt size sand and clay pellets for grog, where as in 589-10 the sand was commonly greater than silt size and the grog consisted of a mixture of grog and clay pellets. Samples 364-3 and 613-7 also had similar percentages of sand and grog; however, the paste matrix in 354-3 was unlike all the other samples. The paste matrix in 354-3 was very light (mostly pale yellow 2.5Y 7/4) with a very active b-fabric, which may suggest this was a different clay source from 613-7. Sample 175-1 possibly had grog and bone temper; however, it could not be determined whether the bone was coming from the bone-tempered grog or was added separately. In general, bone was uncommon in the paste, but some pieces were large. Sample 125-1-6 had grog, bone, and shell in the paste; however, the bone was likely just from the bone-tempered grog given the rarity and small size and the shell was likely a natural inclusion in the clay given the rarity in the paste.

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APPENDIX D: Comparison of the Petrographic and INAA Analysis Results, 41HM51

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Comparison of the Petrographic and INAA Analysis Results, 41HM51

Steve A. Tomka

During the fall of 2013, eleven sherd fragments were received from Prewitt and Associates from 41HM51. Mr. Karl Kibler, the Principal Investigator for the project, provided the following summary on the site well after the completion of the petrographic analysis and just as the INAA raw data was being analyzed :

"Site 41HM51 is situated on top of a buried soil within a late Holocene terrace of the Leon River in the Western Cross Timbers (the principal substrate of the Western Cross Timbers is the lower Cretaceous Antlers Sand). The buried soil at 41HM51 is pedogenically, chronologically, and geomorphically similar to the Leon River paleosol that we see downstream on the Leon River at Fort Hood. This paleosol (at Fort Hood and upstream at 41HM51) is a dark clayey to loamy Mollisol, dates to around 1500-1000 BP, and contains Late Archaic (Darl) and Austin Phase materials. Our Toyah materials, including the ceramics, at 41HM51 clearly rest on top of the buried soil, which is buried by up to 200 cm of interbedded mud and fine quartz sand. Given their context, the Toyah materials appear to represent a single occupation, though our radiocarbon chronology spans the entire Toyah period (AD 1250 to 1700) but as many as five temporal units may be evident in the distribution of the 18 radiocarbon dates from the site." (Kibler Personal Communication, December 2014)

The sherd samples were to be subdivided into two fragments with the goal of conducting petrographic analysis on one set of samples and Neutron Activation Analysis of the second set of the paired samples. Subsequently, each specimen was subdivided into two fragments. One fragment of each sample was then submitted to National Petrographic Services for the production of thin sections for petrographic analysis. Upon receipt of the thin sections they were subjected to systematic petrographic analysis. Upon the completion of the petrographic analysis, the paired samples of the eleven vessel fragments were submitted to the Missouri University Research Reactor for INAA study. The results of the individual petrographic and INAA analyses are provided in the respective analysis reports. In this section, the results of the individual analyses are examined in greater detail, are compared to each other, and overall suggestions are advanced regarding the manufacture origins and cultural affinities of the samples examined.

The Petrography Analysis

The petrographic analysis resulted in the definition of two clay paste groups (Barkwill-Love 2014). Only five specimens could be classified into these two groups, with the remaining six specimens left unclassified. The three specimens placed in Group 1 have moderate to high sand percentages and low grog percentages. However, the principal trait that appears to separate them from the Group 2 specimens is that they have consistently high percentages of angular quarts grains (45.45 percent and higher). The two specimens in Group 2 are similar to Group 1 samples in terms of sand percentage, and have two of the three highest percentages of grog of all eleven specimens studied. In addition, they have moderate to low angular sand grain percentages. The six unassigned specimens appear to be a mixed group.

A close review of the petrographic analysis results indicates a number of interesting trends in the small sample. For instance, burned bone inclusions are noted in five of the sherd samples. In each of these cases, the frequency of bone inclusions is so small that while they were observed during the scans of the slides, bone was not identified during the systematic point counting stage of the analysis. The small size of the bone fragments and their presence within the grog fragments that are part of the tempering agent of these five specimens, suggest that the bone derives from the bone-tempered grog fragments that in turn were used as aplastic inclusions in the manufacture of the vessels from which the sherds in the sample derive.

A review of the raw point count data suggests, however, that the presence of bone in the clay fabric of a sherd sample may be at least in part conditioned by the count of aplastic inclusions per slide. For instance, all four of the specimens with aplastic inclusion counts exceeding 66 have bone tempering. In contrast, only one specimens with an aplastic inclusion count below 66 (n=57) has bone tempering.
Another intriguing pattern noted in the petrographic data is that the three sherds (515-11; 589-10, and 613-7) with the lowest percentages of angular sand constituents (10, 17 and 18 percent, respectively) in the temper have no bone tempering. In contrast, 5 of the 8 (62.5%) specimens with angular sand temper percentages exceeding 23%, have bone tempering.

It is expected that rounded quartz grains are more commonly found in alluvial contexts while angular grains are most common in eolian depositional settings. The association of bone tempering with clays containing primarily angular quartz and the absence of bone tempering in the clays containing low percentages of angular grains suggests two distinct clay procurement localities that may also coincide with two distinct pottery manufacture traditions.

Finally, two samples stand out within the group of six unclassified specimens. These are specimens 589-10 and 304-4. These sherds may form a subgroup primarily on the basis of the abundant presence of mica in the clay fabric. Mica is uncommon or entirely absent in the other nine sherds analyzed. Therefore, it is possible that these two sherds may also represent a source of clay that is distinctive from the others mentioned above.

The Neutron Activation Analysis

The INAA study resulted in the definition of three compositional groups within the small sample of sherds (Ferguson and Glasscock 2014). Group A contained four sherds, Group B also four samples, and Group C included three specimens. Prior to the comparison of these compositional groups to the existing regional databases, Ferguson requested background information on the site. Tomka informed Jeff Ferguson that the samples were Caddoan ceramics, based on the petrographic analysis results. Ferguson in turn initiated a comparison of the sherd samples to the Caddo INAA database. The preliminary conclusions of this comparison are reproduced below, because they are germane to interpretations regarding the cultural affiliation of the site and associated ceramics.

"The specimens fall into three very distinct groups. Group 1 consists of samples 238 (175), 241 (386-5), 242 (125-1), and 248 (196-12). This group is most similar to the bulk of the existing Caddo database, ……… Group 2 includes 239 (364-3), 243 (613-7), 244 (118-8), and 245 (130-9). This group fits well with the Caddo region 4 and 5 core groups ……... Group 3 includes 240 (304-4), 246 (589-10), and 247 (515-11). It is a decent match only with Caddo region 9 core ……group." (Ferguson Personal Communication December 2014)

The bulk of the Caddo comparative database regions are located in northeast Texas. Regions 4 and 5 are located in northeast Texas and encompass sites in Camp, Franklin, Marion, Rains, Upshur, Smith and Wood Counties. Region 9 includes Nackagdoches, Shelby, San Augustin, Cherokee and Houston Counties.

A few days later, when the correct information on the site's affiliation was received from Mr. Kibler and it was forwarded to Ferguson, the INAA data was compared to the Central Texas regional database. It is the results of this comparison that are included in the final INAA report on the small collection of specimens (Ferguson and Glascock 2014). The comparison of the small sample to the much larger Central Texas regional database indicates that three chemically distinct groups of sherds are present within the samples. Of these, only one group, Group B (n=4), fits well with two of the established Central Texas Reference Groups, namely Groups 10 and 11 (Ferguson and Glascock 2014:7-8). Groups 10 and 11 are similarly situated stretching from the southeastern corner of the Edwards Plateau (San Antonio region) to its eastern edge (Austin area), central Texas and including portions of the Gulf Coastal Plains (i.e., Refugio County).

Since Central Texas Groups 10 and 11 loosely overlap in spatial distribution with the Caddo region 9, one possible interpretation of the results is that the ceramics derive from clays gathered in the coastal plains region. Another, perhaps more feasible explanation is that the ceramics are made of clays that derive from northeast Texas formation. Finally, it is also possible that the vessels are a mixed group made of clays from both regions and this variability is simply representative of the scale of mobility of the groups that are responsible for their manufacture.

Comparison of the Petrographic and NAA Results

The table below provides the comparison of group assignments of the eleven sherd samples by petrographic and INAA analyses. There is significant overlap in the percentage of sand as aplastic inclusions in the three groups. However, there appears to be some separation between the groups in terms of grog percentages within the clay fabric. Specifically, Group B specimens have grog percentages ranging from 1.22 to 2.1. These specimens have the four lowest percentages of grog among the entire sample. Group C has specimens with grog percentages ranging from 4.28 to 7.46 and sand/quarts inclusions between 14.4 and 17.16. It is the most internally consistent INAA group. Group A specimens have a wide range of grog percentage ranging from 2.82 to 10.23 percent. Hierarchical cluster analysis of the INAA data indicates that Groups A and B are relatively closely linked to each other with Group C reasonably distinct from the other two groups.

Sample ID/INAA ID	Petrographic Paste Group	INAA Compositional Group
118-8/244	1	B
130-9/245	1	B
386-5/241	1	A
515-11/247	2	C
196-12/248	2	A
304-4/240	Unassigned	C
589-10/246	Unassigned	C
613-7/243	Unassigned	B
175-1/238	Unassigned	A
125-1/242	Unassigned	A
364-3/239	Unassigned	B

It is evident that the INAA and paste group memberships cross-cut each other. None of the petrographic groups contain specimens form a single INAA compositional group. Rather, the three INAA groups are spread among the two defined paste groups and the additional six unassigned specimens. Three of the samples that contain bone tempering as part of the grog inclusions into the final clay fabric are part of INAA group A, the remaining two are split between Group B and C. These three make up 75% of the Group A sample. Group B specimens consist of the subgroup of samples with the four lowest grog temper percentages, only one of these contains bone as a tempering agent.

Overall Conclusions

The analysis of ceramic sherd types to document their petrographic characteristics in order to then turn around and use those traits to define the type, is a circular exercise. Barkwill-Love (2012) has recently carried out a petrographic analysis of Leone Plain and Caddo ceramics. The sherd samples came from sites that were identified as Toyah Phase or Caddo by regional archaeologists and therefore, it has been assumed that the ceramics are representative of either Toyah or Caddo ceramic-manufacture traditions. This assumption, however, does not consider the possibility that some sherds from these sites may derive from traded vessels or vessels made by different manufacture traditions. Therefore, the interpretations provided below should be considered quite critically.

A petrographic analysis of 118 Leon Plain ceramics from twelve central and south-central Texas sites carried out by the same petrographic analyst as in the current study, has found that the clay fabric of Leon Plain sherds never contained grog as a tempering agent (Barkwill-Love 2012). Seven of the specimens had no bone as tempering but within the remaining 111, the percentage of bone temper ranged from a low of 2.1% to a high of 34% of the aplastic inclusions. Quartz grains were also quite common in the clay fabric, ranging from less than 1 percent to 32.5% of the aplastic inclusions. These general characteristics of Leon Plain sherds have also been noted by Kitteman (1994) in his analysis of the Buckhollow site vessels. His sample included 30 sherds and the petrographic analysis identified no specimens with grog temper and bone temper percentages ranging from 6.7% to 25.3%. Heartfield's (1966) very early analysis of Leon Plain sherds from various sites from central Texas found that the sherds that were clearly associated with the Toyah Phase were tempered with bone and/or sand and lacked grog or ground up sherds (1966:Table 23).

In contrast (Barkwill-Love 2012), among the 68 sherds attributed to the Caddo ceramic tradition, grog was absent in only 4 of the samples (6%), while bone was present in 29 of the sherds (43%). These patterns indicate that the likelihood of encountering Caddo manufactured sherds with bone tempering is a great deal higher than the likelihood of finding Leon Plain sherds with grog tempering. The range of clay treatment is significantly greater in Caddo assemblages than in Leon Plain assemblages. Within the group of sherds (n=29) with bone tempering, twenty (69%), contain low quantities of bone (i.e., below 2%), six have between 2 and 7% bone, and three have bone tempering exceeding more than 10 percent of the aplastic inclusions. Quartz grains are present in all of the sherd samples and range from 1 to 29 .5%.

The variety of aplastic materials that are found in Caddo ceramics was also confirmed by the recently completed petrographic analysis of a sample of sherds from the Musgano site (41RK19) in the Sabine River basin in East Texas (Tomka, Barkwill-Love and Perttula 2014). The site dates to the 14th and 15th century AD. The sample of 20 sherds that was subjected to petrographic analysis was differentiated into four clay fabric groups. One of the largest groups contained nine specimens and consisted of grog tempered sandy paste sherds with the grog used as tempering also containing bone fragments. In seven of these nine specimens, bone tempering was noted only during the general scan of the slide but was so scarce that it never registered during the systematic point counting. It showed up in the point counting in only two of the nine sherds and accounted for less than1 percent of the aplastic tempering. A smaller group of two specimens consisted of bone tempered sandy paste sherds. No grog is evident in the clay fabric suggesting that these sherds are representatives of a distinct pottery manufacture tradition (Tomka, Barkwill-Love and Perttula 2014). Finally, Cecil (2013) analyzed a sample of 23 ceramic sherds from 41CP220 and 41CP21. The paste group with the largest number of specimens (n=11) is the sandy paste bone and grog tempered group. In five of these samples, bone temper frequencies are less than 1% suggesting that they may derive from the grog which may itself have been bone tempered.

Overall, then, ceramic assemblages from archaeological sites found in the Caddo culture area do contain vessels that are manufactured of sandy clays tempered with grog (Perttula and Ellis 2013). In some instances the grog is bone tempered and in others, bone tempering is added to the clay fabric in addition to the grog. In the Jewett Mine sites along the Trinity River drainage, grog and bone tempered pottery is common in archaeological components dating between A.D. 900 and 1400 (Perttula and Ellis 2013).

The preliminary comparison of the samples to the east Texas Caddo Reference Group resulted in an overall better fit of the samples with this comparative database compared to the Central Texas Reference Group. The prevalence of grog tempering in the clay fabric also seems to suggest technological affinities to the pottery manufacture traditions of northeast Texas, like of Caddo affiliation. Having concluded this, it is important to note, however, that pottery vessels do not people make. That is, while the vessels may have been made using ceramic manufacture traditions that have affinities to the Caddo culture area, who was responsible for their manufacture, and what was their relationship to the hunter-gatherer group that generated the bulk of the material culture at 41HM51 is not known and a multitude of scenarios could be advanced to explain them.

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APPENDIX E: A Consideration of the Aboriginal Ceramic Sherds from the Jayroe Site (41HM51), Hamilton County, Texas

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INTRODUCTION

Excavations at the Jayroe site (41HM51) in the Western Cross Timbers of central Texas recovered a small assemblage of aboriginal ceramic sherds (n = 43) from Toyah phase contexts (A.D. 1250–1700). These sherds have been the subject of technological and stylistic analysis (Chapter 5 in this report), petrographic analysis (Appendixes C and D), and instrumental neutron activation analysis (Appendix B). The purpose of these analyses has been to characterize these few sherds with respect to their technological, stylistic, petrographic, and geochemical diversity, and also to establish if these sherds are from vessels manufactured locally or extralocally. Specifically, the concern has been to establish through these various analyses if the sherds from the Jayroe site are from aboriginal vessels made in the general vicinity of the site from local clays, were made in other parts of central Texas, or are sherds from vessels made in the Caddo area of east Texas. Here, I consider the interpretive possibilities arising from the detailed analysis of the Jayroe site sherds.

CADDO CERAMICS IN EAST-CENTRAL AND CENTRAL TEXAS SITES

According to Kenmotsu and Boyd (2012:12, Figures 1.1, 1.4, and 1.6), Toyah phase ceramic vessels found on sites in east-central and central Texas sites "are small, plain, utilitarian…[m]ost have bone temper that is easily seen with the unaided eye or under low magnification. Some are painted or have a red wash or slip; often the interiors have a matte finish from the late application of a thin wash. Some interiors and exteriors were smoothed with wide sticks or cane. Interior surfaces of vessel rims were thinned or sharply beveled; exteriors were floated and sometimes rubbed to a high luster."

They are also primarily plain or undecorated vessels. Sherds from vessels apparently made by ancestral Caddo potters living in east Texas have also been found in a number of sites in east-central and central Texas (e.g., Creel et al. 2013; Kibler 2012; Perttula et al. 2003, 2010; Prewitt 2012; Shafer 2006; Story 1990). These sites date from as early as about A.D. 900 to the early eighteenth century. The central question of concern in identifying and interpreting such sherds from Toyah phase sites, including the sherds from the Jayroe site, is: are the grog- and bone-tempered plain and/or decorated ceramics found on sites in these regions made by Caddo potters living in east Texas and then exchanged/traded with hunter-gatherer groups, or were they made by local peoples, who were either of non-Caddo or Caddo affiliation?

The evidence from the instrumental neutron activation analysis (INAA) and petrographic analysis of samples of sherds from the Chupik and Asa Warner sites as well as sites at Fort Hood (see Perttula et al. 2003), similar analyses from other central Texas sites (see Creel et al. 2013; Perttula et al. 2010), and the INAA of a large comparative sample of Caddo sherds from more than 150 east Texas Caddo sites (see Descantes et al. 2005; Perttula and Ferguson 2010) indicates that there is a not-too-confident likelihood that "some Caddo pottery may have been made in Central Texas" (Creel et al. 2013:66), particularly Caddo ceramics found in the

"Waco, Belton, to Austin area, mostly from the vicinity of Waco, Temple, and Belton. Practically none of the many Caddo pottery samples from the Edwards Plateau/ west central Texas area has a meaningful probability of membership in any of the Central Texas compositional groups." In the main, however, the petrographic and INAA analysis of much of the decorated pottery sherds with Caddo stylistic and technological attributes found on east-central and central Texas sites would seem to indicate that they are not from vessels produced using central Texas clays by Caddo peoples who had settled in or were periodically using the central Texas region (Perttula et al. 2003:63; but see Perttula et al. [2010] for the notable exception of Caddo sherds from 41BQ285), but are from vessels obtained by prairie hunter-gatherer groups from east Texas Caddo groups living in the Neches and Sabine River basins.

JAYROE SITE CERAMIC ASSEMBLAGE

The ceramic analyses of the Jayroe site sherds (see Chapter 5) identified 43 sherds that could be sorted into seven different groups, from 1 to 12 sherds per group (Table E.1). Three of the sherd groups were considered to represent three different vessels (Vessels 1–3). The other four were unassigned, but three of them (Unassigned A–C on Table E.1) were considered to possibly be from Vessel 1, and the other (Unassigned D) might belong to Vessel 2.

Table E.1. Jayroe site ceramic sherd assemblage

Vessel/Sherd Group	No. of Sherds	Description/Temper	Petrography	INAA
Vessel 1	11	horizontal incised rim, grog and grog-bone	Group 2 (n = 2)	Group A (n = 1) Group C (n = 1)
Vessel 2	8	curvilinear appliquéd body sherds, grog	Group 1 (n = 1) Unidentified (n = 2)	Group B (n = 1) Group C (n = 2)
Vessel 3	12	plain olla-like vessel, grog and grog-bone	Unidentified (n = 2)	Group B (n = 2)
Unassigned A	8	brushed body sherds, grog and grog-bone	Group 1 (n = 2)	Group A (n = 1) Group B (n = 1)
Unassigned B	2	brushed-incised body sherds, grog	Unidentified (n = 1)	Group A (n = 1)
Unassigned C	1	flat base, grog-bone	Unidentified (n = 1)	Group A (n = 1)
Unassigned D	1	fingernail-punctated rows, grog	–	–

Vessels 1 and 2, as well as unassigned groups A, B, and D, have decorative elements, while the sherds from Vessel 3 may be from a plain olla-like vessel, and the Unassigned C sherd is a flat base. Each of the sherd groups are from vessels tempered either with grog or grog-bone; Vessels 1 and 3 have both tempers, as do unassigned sherd groups a and c.

Vessel 1 is a jar that has a series of horizontal incised lines on the rim. It is possible that unassigned sherd groups A and B represent the diagonal brushed body of Vessel 1 and unassigned group C the base. These kinds of decorative elements are common features of east Texas Caddo ceramics, especially utility ware vessels in the Neches-Angelina River basins (see Perttula 2013). Sherds from brushed utility ware vessels, particularly jars, are a distinctive characteristic of Middle (A.D. 1200–1400), Late (A.D. 1400–1680), and Historic (post-A.D. 1680) Caddo sites in much of east Texas. It also appears to be the case that the relative proportions of brushed utility wares increased through time in those areas where brushed vessels were made and used, such that sherds with brushing make up as much as 90 percent of all the decorated sherds in some post-A.D. 1400 east Texas ceramic assemblages. In the east Texas Caddo ceramic sherd database, only a few A.D. 1200–1430 sites have assemblages with high proportions (>60 percent of the decorated sherd assemblage) of brushed sherds; these occur in the mid-Sabine and Big Cypress Creek drainage basins (see Perttula 2015:Table 1). Late Caddo ceramic assemblages in east Texas with high proportions of brushed sherds occur in the upper and mid-Neches (Frankston phase sites), Angelina, and middle Sabine and Big Cypress (Titus phase sites) basins, and at sites of unknown cultural taxonomy on tributaries of the Sabine River west of the Toledo Bend Reservoir area (Perttula 2015:Figure 5). Caddo ceramic assemblages without considerable amounts of brushed sherds occur in the upper Sabine, Sulphur, and Red River basins.

The fact that there is little bone added to the paste of Vessel 1 (and the unassigned groups) also suggests that these sherds, if made by an east Texas Caddo potter, were made by a potter in only certain parts of east Texas. The use of burned animal bone for the temper of ceramic vessels is a distinctive characteristic of certain east Texas Caddo ceramic sherd assemblages, and most ceramic assemblages in the region have some bone-tempered sherds (see Perttula 2015:Table 1). However, assemblages with high proportions (>40 percent of the sherd assemblage) of bone temper are concentrated in only a few locales, most notably in the Toledo Bend Reservoir area along the middle Sabine River and in sites in the Angelina River basin (Figure E.1). Bone-tempered sherds are not a notable feature of Caddo ceramic assemblages in the Neches, upper Sabine, Big Cypress, Sulphur, or Red River basins.

Caddo sites predating A.D. 1400/1450 with a high proportion of bone temper are found only in a few areas in the middle Sabine River basin. Late Caddo (A.D. 1400–1680) contexts with high proportions of bone temper are found in one site in the Trinity River basin and in several sites in the mid-Sabine and Angelina River basins (see Figure E.1). In fact, these sites are part of a previously identified Late Caddo bone-tempered and brushed ceramic tradition (Perttula 2011:Figure 6-71). Vessel 1 at the Jayroe site is apparently from a Late Caddo grog-tempered and brushed ceramic tradition centered in the upper Neches (in Frankston phase sites) and upper Sabine River (in Titus phase sites) basins.

Vessel 2 from the Jayroe site is an everted-rim and grog-tempered jar with curvilinear appliquéd ridges. A fingernail punctated rim (Unassigned D) may also be part of the vessel. The decorative elements are clearly consistent with the Harleton Appliquéd type (Suhm and Jelks 1962:Plate 33). This is a common utility ware in Late Caddo Titus phase (A.D. 1430–1680) sites in the upper Sabine and Big Cypress drainage basins in east Texas (see Perttula 2013); Caddo vessels in these areas were typically grog tempered.

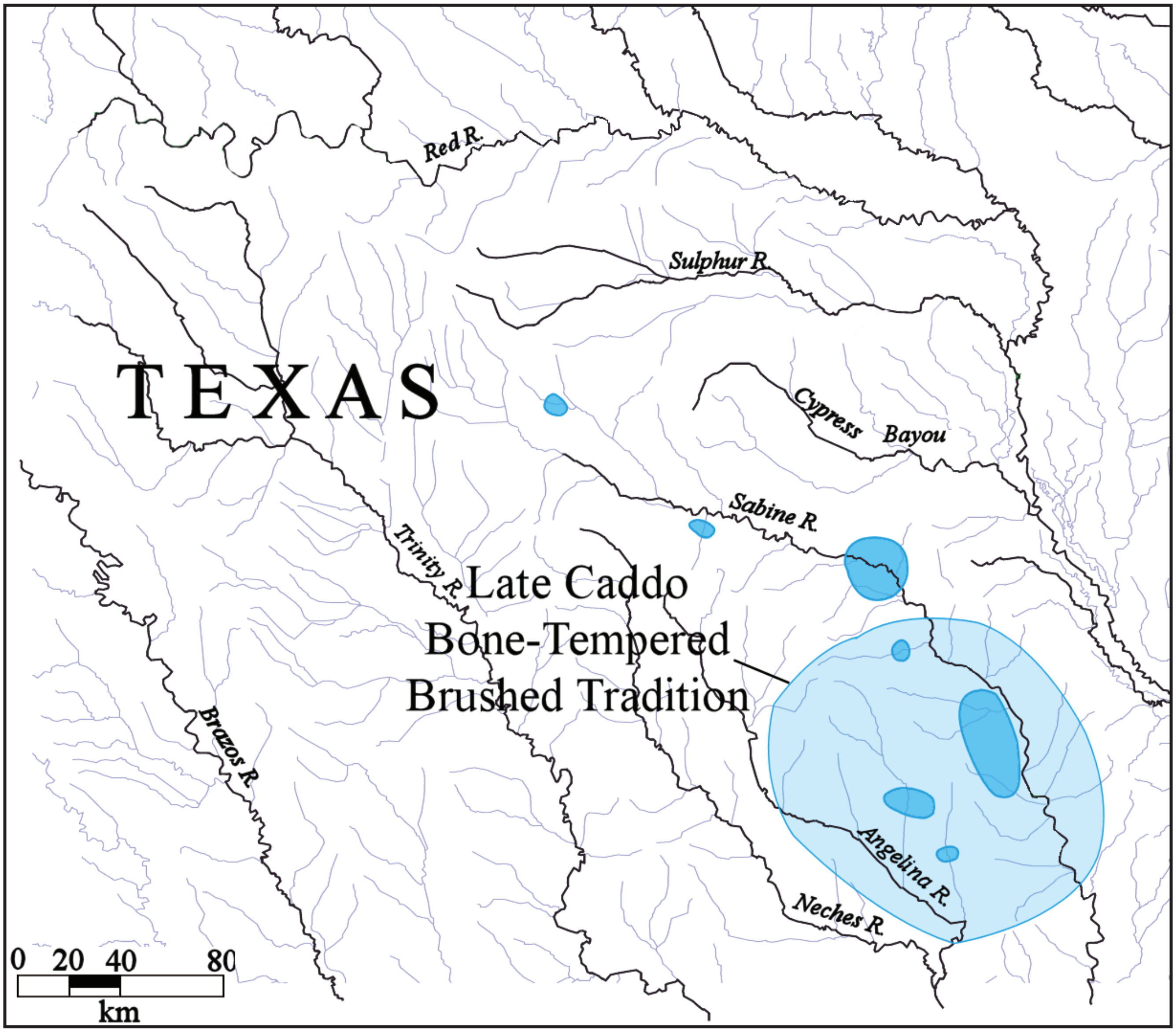

Figure E.1. Clusters of Caddo sites with high proportions (>40 percent) of bone-tempered sherds in east Texas ceramic assemblages.

Vessel 3 includes sherds from the rim and neck of an olla-like vessel. The sherds have grog or grog-bone temper. As Kenmotsu and Boyd (2012:12) note, ollas "with somewhat constricted mouth" are one of the four known Toyah phase vessel types. Ollas were also made by east Texas Caddo potters (see Suhm and Jelks 1962:Plates 3j, 14b–d, 37e, 38n, 41g and i, 59k, 65k–l, and 78k) in the Late Caddo Titus and McCurtain phases and in post-A.D. 1680 Historic Caddo period contexts. These ollas usually have plain rims (but see Suhm and Jelks 1962:Plate 59k) but decorated bodies, either with engraved or brushed decorative elements.

PETROGRAPHIC ANALYSES

The petrographic analysis of 11 sherds from the Jayroe site (see Appendix C) led to the identification of two different petrographic groups—Group 1 with a sherd from Vessel 2 and 2 Unassigned A sherds, thought to be part of Vessel 1—and Group 2 with 2 sherds from Vessel 1. The other 6 sherds were not assigned to a petrographic group: 2 sherds each from Vessels 2 and 3 and single sherds from Unassigned B and C, both thought to be part of Vessel 1.

As detected in the petrographic analysis, the ubiquity of grog as a temper in the manufacture of vessels used at the Jayroe site, and the almost complete absence of bone temper, is particularly notable with respect to considerations of vessel sherd provenance. All of the sherds analyzed by petrography have grog temper, ranging from 1.5 to 10.2 percent of the point counts. The highest proportion of grog temper is in the two Vessel 1 sherds and the Unassigned C base sherd. Only four of the analyzed sherds have bone in the paste. Of these, only the Unassigned A sherd has bone inclusions (a very low 0.4 percent of the point counts) added as temper. The other three sherds—from Vessel 1 and Unassigned C—have bone in pieces of grog, indicating that they came from ground-up sherds from another vessel that had bone temper.

It is disconcerting that sherds sorted into vessel groups in Chapter 4 fall into more than one petrographic group. In the case of Vessel 1, two sherds are in Group 2, but Unassigned A–C, thought to also be part of Vessel 1, are in either Group 1 or unidentified petrographic groups. Similarly, the three sherds from Vessel 2 are in either Group 1 or an unidentified petrographic group. These results suggest that the sorting of sherds into Vessel 1—and the unassigned groups thought to also be part of that vessel—and Vessel 2 may not be of particular utility and/or that the petrographic groupings based on sand size, the proportion of angular sandy grains, and paste coloration instead of the presence of grog, bone, hematite, and mica in the point counts are not useful for distinguishing vessels.

INSTRUMENTAL NEUTRON ACTIVATION ANALYSIS

The instrumental neutron activation analysis of the 11 sherds led to the identification of three groups: A, B, and C (see Table E.1). In comparing the results from the Jayroe site to the 15 previously defined central Texas chemical groups (see Creel et al. 2013:47-49), Group A sherds (a Vessel 1 sherd and Unassigned A–C sherds) are distinct from all the reference groups except Group 15, although Ferguson and Glascock (see Appendix B) note that these "samples differentiate from Group 15 in numerous other bivariate plots." Creel et al. (2013:53, Figure 17) note that other Group 15 sherds are from sites along the Colorado River on the Edwards Plateau, well to the south and west of the Jayroe site.

The Group B sherds (one punctated rim sherd thought to be from Vessel 2, two sherds from Vessel 3, and one Unassigned A brushed sherd thought to be from Vessel 1) are chemically most similar to central Texas Groups 10 and 11, "with a slightly stronger match with Group 11." According to Creel et al. (2013:Figures 20 and 24), the Group 10 and 11 sherds are primarily from sites on the Edwards

Plateau and the Gulf coastal plain well south and west of the Jayroe site and include many Leon Plain, Goliad Plain, untyped bone-tempered plain, and untyped sandy paste plain sherds. One sherd in Group 10C is a Boothe Brushed sherd from the Colorado River basin south of the Jayroe site (Creel et al. 2013:61, Figure 23). Creel et al. (2013:60) also comment that a number of Caddo pottery sherd samples in the central Texas INAA database "have high probabilities of membership in Group 10," but significantly they also note that there is "considerable overlap between Group 10 and most of the previously analyzed Caddo pottery samples from Caddo sites in East Texas." Furthermore, even if these sherds have a high probability of membership in Group 10, this "does not necessarily imply production of Caddo vessels in Central Texas."

The INAA Group C sherds are from Vessels 1 and 2. Inexplicably, other sherds from these two vessels are assigned to other INAA chemical groups: Group A for one sherd from Vessel 1 and Group B for the punctated rim thought to be a part of Vessel 2. Ferguson and Glascock note that the Group C sherds are distinct from "all of the Central Texas Reference Groups except for Group 8, but many other plots show a clear separation from Group 8." Creel et al. (2013:59, Figure 19) suggest that Group 8 sherds have a Balcones Escarpment production zone, well removed from the Jayroe site.

SUMMARY AND CONCLUSIONS

Stylistic, technological, petrographic, and instrumental neutron activation analysis was completed of a small assemblage of ceramic sherds (n = 43) from as few as three separate vessels from the Jayroe site. The ceramic sherds are associated with a Late Prehistoric Toyah phase occupation.

The decorative elements on the sherds are consistent with those on Caddo utility ware vessels from the Neches, Sabine, and Big Cypress drainage basins in east Texas in Late Caddo (A.D. 1400–1680) Titus phase and Frankston phase contexts. Vessel 3 from the Jayroe site is the rim and neck of an olla-like vessel. Ollas were also made by Titus phase Caddo groups in the Sabine and Big Cypress basins. Additionally, Caddo ceramic vessels made in the upper parts of these three drainage basins are primarily grog tempered, with little bone being used in vessel manufacture.

The Jayroe site ceramic sherds are from grog-tempered vessels, with very limited use of burned bone as a temper (and in three of the four sherds with bone, the bone is within pieces of grog), and thus they share technological and manufacturing practices with east Texas Caddo ceramics rather than with the primarily bone-tempered (and plain) ceramic vessels thought to have been made locally by east-Central and central Texas Toyah phase groups (e.g., Creel et al. 2013).

Comparison of the INAA results to the central Texas database suggests the sherds from the site are associated with central Texas Groups 8, 10/11, and 15. Except for the Caddo sherds in Group 10 that chemically overlap with sherds more likely to be from vessels made in central Texas, the sherds included in these groups have Edwards Plateau and Gulf coastal plain production locales well to the south and west of the Jayroe site. These sherds are primarily from bone-tempered and sandy paste vessels that are stylistically and technologically distinct from the Jayroe site sherds.

Tomka (see Appendix D) notes that the Jayroe site sherds were also compared to the east Texas Caddo INAA database. The Jayroe site sherds were found to be compositionally very similar to the sherds in the existing Caddo INAA database, and Vessels 1 (incised-brushed) and 2 (Harleton Appliquéd) were matched with east Texas core chemical Groups 4/5 and 9 (see Perttula 2013:Figure 9). The incised-brushed sherds from Vessel 1 match with Group 9, which includes sherds from the Neches and Angelina River basins; utility ware vessels with the kind of decorative elements noted on Vessel 1 are common in those parts of east Texas. One of the Vessel 2 sherds and both sherds from Vessel 3 match with the Group 5. This group includes sites in the upper Sabine and Cypress drainage basins, an area densely occupied by Late Caddo Titus phase groups.

Based on the preponderance of the evidence, it appears most likely that the Jayroe site sherds are from grog-tempered vessels manufactured by Caddo potters living in east Texas communities. The decorative elements on Vessels 1 and 2 are consistent with utility ware vessels made in post-A.D. 1400 Frankston and Titus phase sites in the Neches, Sabine, and Big Cypress drainage basins (particularly the upper parts of these basins, where not much bone-tempered Caddo pottery is present), and the INAA comparisons point to these same areas as the manufacturing locales of the vessels that were eventually used by non-Caddo groups that lived at the Jayroe site.

ACKNOWLEDGMENT

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APPENDIX F: Plant Remains from the Jayroe Site (41HM51)

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INTRODUCTION

Seven carbon samples, 5 botanical lots, and 15 flotation samples from testing and data recovery at the Jayroe site (41HM51) were submitted for analysis. The site is located in and on a buried paleosol on a first terrace of the Leon River at the County Road 294 crossing. The paleosol texture is silty to clayey; overlying sediments are silty to sandy. The artifact-bearing paleosol was quickly buried, resulting in unusually good preservation of charcoal.

ENVIRONMENT AND PRESERVATION

The Jayroe site is near the northwestern edge of the Lampasas Cut Plain, a vegetation area grouped variously with the Edwards Plateau (Riskind and Diamond 1988) or the Cross Timbers (Diggs et al. 1999; Gould 1962). Because of its location and topographic diversity, the vegetation in the Lampasas Cut Plain is variable, resembling that on the Edwards Plateau, the Blackland Prairie, or the Cross Timbers. In northwestern Hamilton County, the resemblance is more to the Cross Timbers where a mosaic of grasslands and woodlands would have characterized the upland vegetation in pre-Columbian times. Native grasslands in Hamilton County tend toward mixed prairie, with tall, medium, and short grasses present. Upland trees and shrubs typically grow in mottes where oaks (*Quercus* spp.) are the most common tall trees. Yaupon (*Ilex vomitoria*), elbowbush (*Forestiera pubescens*), Texas persimmon (*Diospyros texana*), agarita (*Mahonia trifoliata*), and sumac (*Rhus* spp.) are common small trees and shrubs. (Beaty 1978; Riskind and Diamond 1988). Riparian vegetation near the Leon River would have been significantly different, however, characterized by species that thrive in moist, disturbed environments. Typical riparian trees of central Texas are black willow (*Salix nigra*), cottonwood (*Populus deltoides*), sycamore (*Platanus occidentalis*), and buttonbush (*Cephalanthus occidentalis*) nearest the channel with oaks, pecan (*Carya illinoinensis*), hackberry (*Celtis laevigata*), elms (*Ulmus* spp.), and ashes (*Fraxinus* spp.) on the higher floodplain and terraces. Scattered pecans, oaks, and cedar elm trees were noted at the site location in this century. Understory trees available in the riparian zone and the steep terrain associated with nearby drainages include hawthorns (*Crataegus* spp.), Carolina buckthorn (*Frangula caroliniana*), roughleaf dogwood (*Cornus drummondii*) Mexican plum (*Prunus mexicana*), rusty blackhaw (*Viburnum rufidulum*), and possumhaw (*Ilex decidua*).

METHODS

Flotation samples from the Jayroe site were processed at Prewitt and Associates, Inc., in a Flot-Tech flotation machine with bottom mesh openings of 1.0 mm. Any charcoal remaining in the flotation heavy fractions was removed and added to the light fractions at Prewitt and Associates.

Flotation samples were sorted according to standard procedures at the Macrobotanical Analysis laboratory in Manchaca, Texas (Pearsall 2000). Each flotation sample was weighed on an Ohaus Scout II 200 x 0.01 g electronic balance before being size sorted through a stack of graduated geologic mesh. Materials that did not pass through the No. 10 mesh (2-mm square openings) were completely sorted under a Micros stereozoom microscope at 7–45x, and all carbonized botanical remains were counted, weighed, recorded, and labeled. Uncarbonized botanical materials that did not pass through the 2-mm mesh (rootlets, soil clumps, and gastropods) were weighed, recorded, and labeled as "contamination." Materials that fell through the 2-mm mesh ("residue") were examined for carbonized botanical remains not previously identified in the larger size fraction. Carbonized botanical material from the residue not previously identified in the larger size fraction was counted, weighed, recorded, and labeled. Uncarbonized macrobotanical remains other than rootlets were recorded on a presence/absence basis on laboratory forms.

The flotation samples represent 106 cubic decimeters of feature fill. The combination of good charcoal preservation and large flotation volumes resulted in very large light fractions for three samples from Features 6, 8, and 10. Sorting of these samples was reserved until last, when it was apparent that few nonwood plant parts are present in the site assemblage. A random subsample of 40 or 60 g of light fraction material was analyzed for each of these samples, making them still among the largest light fractions analyzed. The flotation volumes given for these three samples in Tables F.1 and F.2 are estimates based the proportions of the light fraction analyzed. The actual flotation volume processed was considerably greater in all three cases.

Carbon samples and botanical lots were subject to full radiocarbon protocols in the laboratory. The samples were sorted on freshly washed glassware and handled only with latex gloves or metal forceps, and contact with paper was avoided. Writing instruments used in data entry were plastic mechanical pencils. Carbon samples and botanical lots were sieved through a No. 10 mesh (2-mm square openings). Soil clumps and wood charcoal larger than 2 mm were separated by hand. Material that fell through the mesh was scanned for plant parts other than the wood charcoal that was also present in the larger size fraction. None was found, and the residue was weighed, bagged, and labeled.

Identification was attempted for 20 wood charcoal specimens from each sample. When fewer than 20 fragments larger than 2 mm were present, identification was attempted for progressively smaller fragments taken from the residue smaller than 2 mm until identification became impractical or until 20 fragments were identified. For wood charcoal fragments from carbon samples and botanical lots, the largest pieces were selected for identification first to best identify the concentration of wood that attracted the attention of the excavator in the field. Wood charcoal fragments identified from the flotation samples were randomly selected. Accordingly, wood taxa identified are listed in descending order by weight for the carbon samples and botanical lots and by count for the flotation samples. Wood charcoal fragments were snapped to reveal a transverse section and examined under a stereoscopic microscope at 28–180X magnification. When necessary, tangential or radial sections were examined for ray seriation, presence of spiral thickenings, types and sizes of intervessel pitting, and other minute characteristics that can only be seen at the higher magnifications of this range.

Botanical materials were identified to the lowest possible taxonomic level by comparison to materials in the Macrobotanical Analysis comparative collection and through the use of standard reference works (e.g., Core et al. 1979; Davis 1993; Hoadley 1990; InsideWood 2004–onwards; Martin and Barkley 1961; Panshin and de Zeeuw 1980; Wheeler 2011). Plant nomenclature follows the PLANTS database (USDA, NRCS 2014).

RESULTS

Identifications of plants from the Jayroe site flotation samples are given by count in Table F.1 and by weight in Table F.2. Identifications for carbon samples and botanical lots are shown in Table F.3. Flotation sample plants consist primarily of wood charcoal, but some nutshell and seeds (all but two taxa also represented as wood) were also recovered. Only wood charcoal was identified in the carbon samples and botanical lots. Faunal material was encountered in all flotation samples, usually in the form of gastropods. In addition, a sample from Feature 10 produced a small bone, and a sample from Feature 17 yielded two small fish scale fragments.

Seed Rain and Leaf Litter from Flotation

Uncarbonized pecan nutshell, uncarbonized leaves (probably hackberry), and three taxa of uncarbonized seeds were recovered from flotation samples (see Table F.1). Two of the three seeds belong to annual herbaceous taxa and are interpreted here as modern seed rain. The delicate leaves of hackberry are also unlikely to have survived many centuries, even in a buried paleosol, and are likewise interpreted as modern introductions. The tougher pecan nutshell and hackberry seeds, however, may represent ancient plants. Hackberry seeds, with their high mineral content, survive well in the soil and frequently appear in geological deposits in North America (Wang et al. 1997). Hackberry and pecan were found among the carbonized woods on the site, so the trees were present in the site area during ancient times. As noted above, however, they are also present in modern times. In the interest of caution, the uncarbonized pecan nutshell and hackberry seeds are interpreted with the other uncarbonized plants as modern. In any event, conditions at the site seem to have provided a favorable environment for pecans and hackberries in both ancient and modern times.

Carbon Samples and Botanical Lots

Plant material in the 12 carbon samples and botanical lots consist entirely of wood charcoal (see Table F.3). Elm is the most common wood type (6.31 g). It falls into the hard elm subgroup that includes rock elm (*Ulmus thomassii*), winged elm (*Ulmus alata*), and cedar elm (*Ulmus crassifolia*). The only member of this group in Hamilton County today is cedar elm, and it is very likely the elm species represented at Jayroe. Pecan or other hickory is the next-most-common wood, followed by oak of the white group. Like cedar elm, these are trees that would have been common in the Leon River floodplain in prehistoric times, as they are today. The only wood type recovered in the carbon samples and botanical lots that is not also present in flotation is plateau live oak (*Quercus fusiformis*), a tree that would have been present in upland or terrace landscapes but unusual in floodplain settings.

Table F.1. Material from flotation samples (raw counts; all plants carbonized unless indicated)

Unit	BHT 7	BHT 7	TU 8	TU 8	TU 10	TU 16/17	EU 13/14	EU 13/14	EU 44, 45, 47, 48	EU 25–28, 81–82	EU 85	EU 145, 153	EU 156	EU 156, 142	EU 136	Totals
Elevation (m)	98.49–98.39	98.49–98.39	98.29–98.21	98.29–98.15	98.29–98.15	97.82–97.61	98.69–98.59	98.63–98.52	97.75–97.83	98.11–97.92	97.80–97.70	97.62–97.55	98.55–98.50	98.50–98.41	97.66–97.60	
Feature	4	4	5	6	6	8	10	10	11	12	13	14	16	16	17	
Flotation volume (cu. dm.)	1.50	1.50	2.00	9.25	2.50*	2.50*	9.50	4.00*	4.00	35.50	5.00	6.50	7.50	10.50	4.25	106.00
Wood																
White group oak (*Quercus* subg. *Quercus*)	6	9	6	2	1	5	7	4	14	10	8		7	8	8	95
Elm (*Ulmus* sp.)	4	3				6	11	15		5		17	3	5		69
Hickory/pecan (*Carya* sp.)		4		17	10	1				2		1	1	2	9	47
Mulberry (*Morus* sp.)	3									2	1	1	4	3		14
Hackberry (*Celtis* sp.)				1	6	1										8
Hawthorn (*Crataegus* sp.)			1			2			1							4
Ash (*Fraxinus* sp.)													3			3
Blackhaw (*Viburnum* spp.)										1			2			3
Elm/hackberry (Ulmaceae)					2											2
Oak, unspecifiable (*Quercus* sp.)									2							2
Dogwood (*Cornus* sp.)						1										1
Soapberry (*Sapindus saponaria*)								1								1
Hardwood	7				1	4	2				3	1		2	3	23
Not examined	4			1755	557	752	136	712		20		15	1369	3435		8755
Nutshell																
Pecan (*Carya illinoinensis*)	3	28									14					45
Acorn (*Quercus* sp.)							1									1
Seed																
Sedge (*Carex* sp.)												1				1
Hawthorn (*Crataegus* sp.)	1			1												2
Indeterminable									4							4
Tuber																
Indian breadroot (*Pediomelum* sp.)						1										1
Uncarbonized plant parts																
Leaf, cf. hackberry (*Celtis* sp.)									X							
Pecan nutshell (*Carya illinoinensis*)	X															
Hackberry seed (*Celtis* sp.)			X				X			X		X		X	X	
Goosefoot seed (*Chenopodium* sp.)										X						
Coneflower seed (*Rudbeckia/Echinacea* sp.)								X		X				X		
Bark				7	2	22		5		6				75		117
Bud										1						1
Fungus														1		1
Gall										8						8
Indeterminable											7	2				9

*Actual feature matrix processed is higher. Volume shown here is an estimate based on the percentage of the light fraction that was analyzed.

Table F.2. Material from flotation samples (weights in grams; all plants carbonized unless indicated)

Unit	BHT 7	BHT 7	TU 8	TU 8	TU 10	TU 16/17	EU 13/14	EU 13/14	EU 44, 45, 47, 48	EU 25–28, 81–82	EU 85	EU 145, 153	EU 156	EU 156, 142	EU 136	Totals
Elevation (m)	98.49–98.39	98.49–98.39	98.29–98.21	98.29–98.15	98.29–98.15	97.82–97.61	98.69–98.59	98.63–98.52	97.75–97.83	98.11–97.92	97.80–97.70	97.62–97.55	98.55–98.50	98.50–98.41	97.66–97.60	
Feature	4	4	5	6	6	8	10	10	11	12	13	14	16	16	17	
Flotation volume (cu. dm.)	1.50	1.50	2.00	9.25	2.50*	2.50*	9.50	4.00*	4.00	35.50	5.00	6.50	7.50	10.50	4.25	106.00
Wood																
Hickory/pecan (*Carya* sp.)		0.02		0.56	0.19	0.04				0.01		0.01	0.01	0.04	0.02	0.90
Hackberry (*Celtis* sp.)				0.02	0.23	0.01										0.26
Dogwood (*Cornus* sp.)						0.08										0.08
Hawthorn (*Crataegus* sp.)			0.02			0.13			0.01							0.16
Ash (*Fraxinus* sp.)													0.09			0.09
Hardwood	0.04				0.01	0.07	0.10				0.01	0.02		0.03	0.01	0.29
Mulberry (*Morus* sp.)	0.01									0.01	0.01	0.01	0.09	0.05		0.18
Not examined	0.01			16.15	5.35	23.45	0.9	16.38		0.06		0.05	19.72	36.41		118.48
Oak, unspecifiable (*Quercus* sp.)									0.01							0.01
White group oak (*Quercus* subg. *Quercus*)	0.05	0.06	0.03	0.02	0.01	0.18	0.13	0.2	0.07	0.04	0.02		0.35	0.15	0.02	1.33
Soapberry (*Sapindus saponaria*)								0.01								0.01
Elm/hackberry (Ulmaceae)					0.03											0.03
Elm (*Ulmus* sp.)	0.03	0.01				0.30	0.19	0.41		0.02		0.12	0.12	0.26		1.46
Blackhaw (*Viburnum* spp.)										0.01			0.07			0.08
Nutshell																
Pecan (*Carya illinoinensis*)	0.03	0.19									0.04					0.26
Acorn (*Quercus* sp.)							0.01									0.01
Seed																
Sedge (*Carex* sp.)												0.01				0.01
Hawthorn (*Crataegus* sp.)	0.02			0.01												0.03
Indeterminable									0.01							0.01
Tuber																
Indian breadroot (*Pediomelum* sp.)						0.03										0.03
Bark				0.03	0.03	0.35		0.04		0.02				0.80		1.27
Bud										0.01						0.01
Fungus														0.01		0.01
Gall										0.02						0.02
Indeterminable											0.02	0.01				0.03
Fauna (not carbonzied)								0.04							<0.01	0.04
Contamination	0.11	0.17	0.19	0.99	13.49	0.71	0.51	0.58	0.52	2.56	0	0.65	1.12	1.29	0.43	23.32
Residue	1.50	0.78	1.02	61.94	20.66	34.68	2.51	22.34	1.23	6.37	0.03	1.99	19.12	44.41	2.64	221.22
Total	1.80	1.23	1.26	79.72	40.00	60.03	4.35	40.00	1.85	9.13	0.13	2.87	40.69	83.45	3.12	369.63

*Actual feature matrix processed is higher. Volume shown here is an estimate based on the percentage of the light fraction that was analyzed.

Table F.3. Material from carbon samples and botanical lots (counts and weights in grams)

Sample	Testing, C-2	Testing, C-7	Testing, C-9	Testing, C-14	Testing, C-15	Testing, Lot 1	Testing, Lot 103	DR, C-6	DR, C-7	DR, Lot 313	DR, Lot 511	DR, Lot 680	
Unit	TU 1	TU 7	TU 8	TU 8	TU 14	TU 1	TU 15	EU 148	EU 148	EU 45	EU 95	EU 149	
Elevation (m)	98.72–98.62	98.35	98.25	97.66	97.82	99.12–99.02	97.83–97.73	97.80–97.70	97.70–97.60	97.90–97.80	97.70–97.60	97.80–97.70	Totals
Wood charcoal													
Elm (*Ulmus* sp.)							4 (2.35)		10 (3.96)				14 (6.31)
Hickory/pecan (*Carya* sp.)		1 (0.44)	20 (1.56)	13 (0.34)	3 (0.26)	2 (0.22)					1 (0.19)		40 (3.01)
White group oak (*Quercus* subg. *Quercus*)							4 (2.11)			4 (0.33)		1 (0.13)	9 (2.57)
Blackhaw (*Viburnum* spp.)	2 (0.36)							5 (0.1)					7 (0.46)
Elm/hackberry (Ulmaceae)					2 (0.23)			1 (0.02)					3 (0.25)
Hackberry (*Celtis* sp.)							1 (0.18)						1 (0.18)
Mulberry (*Morus* sp.)								12 (0.06)					12 (0.06)
Plateau live oak (*Quercus fusiformis*)								3 (0.05)					3 (0.05)
Hardwood					15 (2.54)				10 (1.95)				25 (4.49)
Not examined			24 (0.14)		38 (0.38)				623 (8.35)				685 (8.87)
Residue (soil and wood charcoal flecks<2 mm)			0.58	0.10	1.23			24.37	8.49				34.77
Soil					3.65				26.85				30.50

Flotation Samples

Wood charcoal. Plant material in the 15 flotation samples consists largely but not exclusively of wood charcoal (see Tables F.1 and F.2). As in the other samples, the most common woods are white group oak, elm (probably cedar elm), and a species of hickory (probably pecan). Mulberry is the next-most-common wood, followed by hackberry, hawthorn, ash, blackhaw, dogwood, and soapberry. All except blackhaw are common floodplain species, but oaks, elm, and hackberry are frequently found in upland situations as well as floodplains. Blackhaw prefers rocky or sandy woodlands (Diggs et al. 1999:511).

Ecologists will note the lack of boxelder (*Acer negundo*) in the Jayroe site assemblage. Boxelder, a member of the maple genus, is a common floodplain tree of central Texas. Boxelder and two of the woods identified (blackhaw and dogwood) belong to the wood anatomical group that Bruce Hoadley labels “Subgroup III-3: The Confusing Diffuse-Porous Woods” (Hoadley 1990). In this context, a few notes on the identification of the blackhaw and dogwood at the Jayroe Site are in order. Boxelder and other members of the maple genus can be separated from blackhaw and dogwood by the presence of spiral thickenings in the vessels. No spiral thickenings were observed in the Jayroe site specimens identified as blackhaw or dogwood. Dogwood also has wider rays in relation to the pores than would be expected for boxelder, and the uniseriate tails characteristic of dogwood were observed in the rays when viewed in tangential section. The blackhaw specimens have smaller and more numerous pores than boxelder, but not so small and numerous as sweetgum or tulippoplar, which in any event would not be expected in Hamilton County. The rays are mostly biseriate (range 1–3), and ray cells appear upright in the few clean radial sections that could be obtained.

Economic uses of fruits associated with fuel wood taxa. The trees present at the Jayroe site in the form of wood charcoal include species with important uses for food. Mulberry and blackhaw have edible fleshy fruits that can be eaten raw (Diggs et al. 1999). The seeds of mulberry are small enough to swallow, so they would not typically be preserved through carbonization. Hackberry and hawthorn have dry fruits that are less palatable than mulberries and blackhaws but edible nonetheless (Diggs et al. 1999). Hackberry fruits can be an important source of calcium if the large seed is consumed, as when hackberry fruits are ground into a paste for making travel foods (Moerman 1998). Acorn and especially pecan nuts are excellent sources of dietary fat (USDA, ARS 2011). As noted below, both acorn and pecan nutshells were recovered. The common use of a final economic plant, soapberry, is indicated by its name: the saponins in soapberry fruits have been used for washing by people throughout the range of the genus (Turner 2009).

Nutshell. Nutshell at the Jayroe site is mostly pecan (n = 45, 0.26 g), and one fragment of acorn shell was recovered. Both of these plant taxa were also recovered in the wood charcoal assemblage, but they are not necessarily related to the burning of wood for fuel. Acorn and pecan nuts fall from the trees, leaving behind the acorn caps and pecan husks. The caps and husks, not the nutshells, are more likely to appear in assemblages where the fruit parts were burned incidentally along with firewood.

Seeds. Two features produced one hawthorn seed each. Hawthorn's dry fruits are edible and were widely consumed by native people. Hawthorns also have some medicinal uses, and the thorns were sometimes used in fish hooks (Moerman 1998). A sedge seed was recovered from Feature 14. Sedges of the genus *Carex* are common in woodlands; basketry is the most important economic use of the plant.

Tuber. One tuber fragment recovered from Feature 8 is identifiable as Indian breadroot (*Pediomelum* sp., formerly genus *Psoralea*). Indian breadroot was an important food source across the Great Plains. "*Psoralea* has so important a place in the economy of the Plains tribes and has had for so long a time that it enters into their mythology, folklore, stories, and sleight-of-hand tricks" (Gilmore 1991:41). The tubers can be eaten fresh, cooked or uncooked, or they can be dried and stored for future use (Moerman 1998).

Other nonwood plants. Bark was recovered from six contexts, and a bud, fungus, and gall fragments were recovered from one context each. They are mostly likely present on the site incidental to the burning of wood for fuel.

SUMMARY

Plant remains from the Jayroe site consist of wood charcoal, nutshells, seeds, a tuber, and fragments of bark, fungus, and galls. Most woods identified come from trees that prefer riparian or low terrace habitats, indicating they were collected in the immediate site area. Some upland woods were also recovered. The bark, fungus, and gall fragments are interpreted as having burned in association with wood used for fuel. The Indian breadroot tuber, acorn and pecan nutshell, and hawthorn seeds probably represent food debris. Other plants represented only as wood charcoal also have important uses other than fuel: mulberry, hackberry, and blackhaw all produce edible fruits, and soapberry can be an important cleanser.

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APPENDIX G: Energy-Dispersive X-Ray Fluorescence Analysis Of Obsidian Artifacts from 41HM51, Hamilton County, Texas

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LETTER REPORT

AN ENERGY-DISPERSIVE X-RAY FLUORESCENCE ANALYSIS OF OBSIDIAN ARTIFACTS FROM 41HM51, HAMILTON COUNTY, TEXAS

13 October 2006

Karl W. Kibler
Prewitt & Associates, Inc.
2105 Donley Dr. Suite 400
Austin, TX 78758-4513

Dear Karl,

The dominance of obsidian from the Valles Caldera in northern New Mexico is rather typical of late period sites in Texas (Shackley 2005). While the Cerro Toledo caldera collapse and ash flows distributed glass into the Rio Grande alluvium, the Valles Rhyolite (Cerro del Medio) did not, and so had to be originally procured in the caldera proper (Shackley 2005). These samples were near the detection limits for analysis, but at 200 live seconds yielded a good signal, and the assignments should be valid (Davis et al. 1998; Table 1 and Figure 1 here).

The samples were analyzed with a Spectrace (ThermoNoran) *QuanX* EDXRF spectrometer in the Archaeological XRF Laboratory, University of California, Berkeley. Specific instrumental methods and source standard data can be found at http://www.swxrflab.net/anlysis.htm, and Shackley (2005). Analysis of the USGS RGM-1 standard indicates high machine precision for the elements of interest (Govnidaraju 1994; Table 1 here).

Sincerely,

M. Steven Shackley
Professor and Director

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Table 1. Elemental concentrations for the archaeological samples. All measurements in parts per million (ppm).

Site/Sample	Ti	Mn	Fe	Rb	Sr	Y	Zr	Nb	Source
HM51-255	1144	728	10487	208	18	55	174	87	Cerro Toledo Rhy
HM51-389	1130	699	11401	229	5	56	182	96	Cerro Toledo Rhy
HM51-606	1027	708	11156	226	6	48	173	77	Cerro Toledo Rhy
HM51-674	1313	595	10208	180	12	41	155	59	Valles Rhy
RGM1-S1	1739	267	13104	150	113	21	214	8	standard

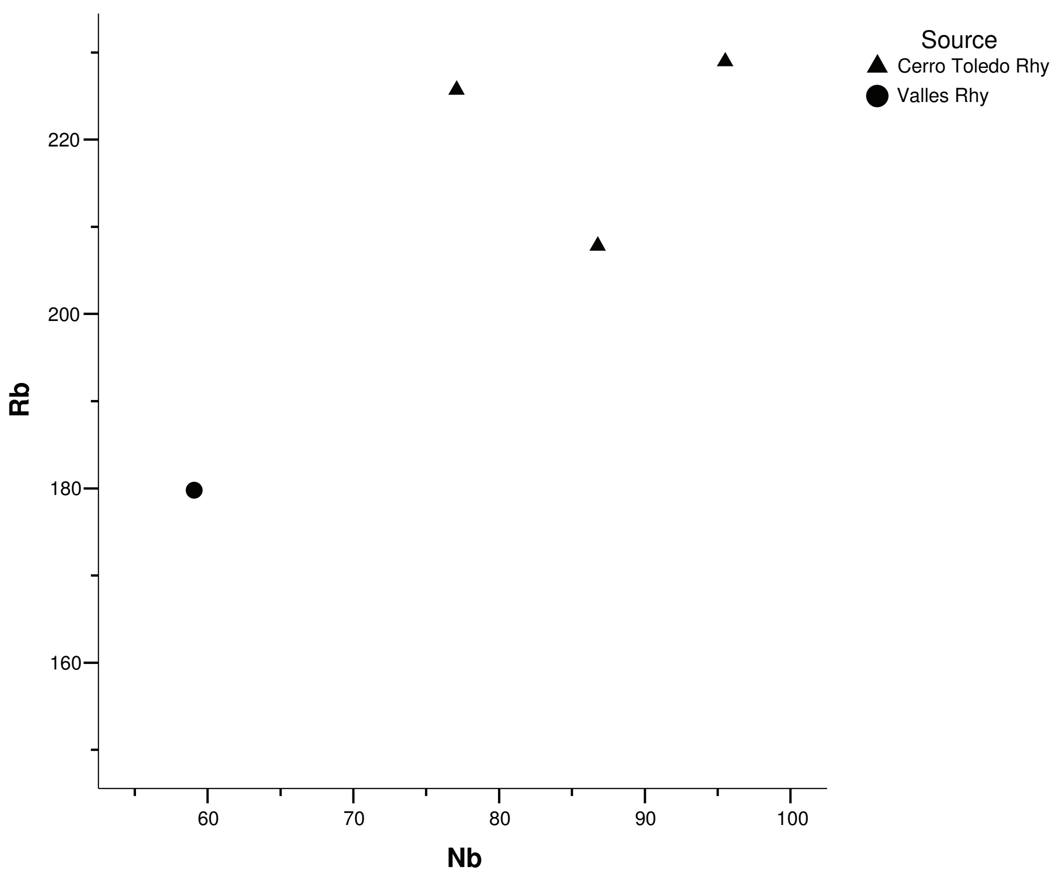

Figure 1. Rb versus Nb biplot of the elemental concentrations for the archaeological specimens.

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LETTER REPORT

AN ENERGY-DISPERSIVE X-RAY FLUORESCENCE ANALYSIS OF OBSIDIAN ARTIFACTS FROM 41HM51, HAMILTON COUNTY, TEXAS

23 November 2013

Karl Kibler
Prewitt & Associates
2105 Donley Dr., Suite 400
Austin, TX 78758-4513

Dear Karl,

As in the previous analysis from this site, the two artifacts were produced from Cerro Toledo Rhyolite and Valles Rhyolite, Valles Caldera, Jemez Mountains, northern New Mexico (Shackley 2005, 2009). While Cerro Toledo obsidian is available as secondary deposits in Rio Grande Quaternary alluvium, Valles Rhyolite (Cerro del Medio) obsidian had to be procured in the caldera proper (Shackley 2013). Specific instrumental methods can be found at http://www.swxrflab.net/anlysis.htm, and Shackley (2005). Source assignment was made by comparison to source standard data in the laboratory. Analysis of the USGS RGM-1 standard indicates high machine precision for the elements of interest (Table 1 here).

Sincerely,

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Table 1. Elemental concentrations for the archaeological samples. All measurements in parts per million (ppm).

Sample	Ti	Mn	Fe	Rb	Sr	Y	Zr	Nb	Pb	Th	Source
516	980	701	13624	247	3	68	175	85	43	38	Cerro Toledo Rhyolite
555-2	679	385	8886	166	8	42	181	47	27	17	Valles Rhyolite
RGM1-S4	1594	268	13374	150	106	25	221	8	25	19	standard

APPENDIX H: Organic Residue (FTIR) and Protein Residue (CIEP) Analysis of Samples from the Jayroe Site (41HM51), Hamilton County, Texas

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Report 2017-073

INTRODUCTION

The Jayroe site (41HM51) is a Late Prehistoric campsite situated in Hamilton County, Texas. The site lies at the northeast margins of the Balconian biotic province, near its boundary with the Texan and Kansan biotic provinces, on the edge of a terrace overlooking the Leon River. The site features three pit hearths, four earth ovens with burned rocks, and eight debris concentrations containing burned rocks, mussel shells, animal bones, and/or lithic artifacts. Fourteen Late Prehistoric stone tools, including 5 ground or battered stone and 9 chipped stone, and 7 ceramic sherds were submitted for either FTIR or protein analysis to identify materials processed.

METHODS

FTIR (Fourier Transform Infrared Spectroscopy)

A mixture of chloroform and methanol (CHM) was used as the solvent to remove lipids and other organic substances that had soaked into the sherds and ground stone implements. Each item was placed in a glass container with CHM solvent, covered, and allowed to sit for several hours, after which the solvent was poured into a small aluminum evaporation dish, where the CHM was allowed to evaporate leaving organic residues behind. To evaporate the entire quantity of CHM, the aluminum dishes were filled repeatedly until all the solution evaporated. The aluminum dishes were tilted during evaporation to separate the lighter fraction (lighter molecular weight compounds) from the heavier fraction (heavier molecular weight compounds), leaving the residue of absorbed chemicals in the aluminum dish after the solvent evaporated. Then the aluminum dish containing the residue was placed residue side down on the FTIR ATR diamond crystal, and the spectra were collected. Lighter and heavier fractions were designated upper (lighter fraction) and lower (heavier fraction), respectively, in the subsequent analysis.

FTIR is performed using a Bruker Alpha optical bench FTIR with an ATR (attenuated total reflection) accessory and a diamond crystal. The aluminum dish containing the sample residue was placed residue side down approximately on the diamond crystal in the path of a specially encoded infrared beam that passes through the crystal, producing a signal called an “interferogram.” The interferogram contains information about the frequencies of infrared light that are absorbed and the strength of the absorptions, reflecting the sample’s chemical makeup. A computer reads the interferogram, uses Fourier transformation to decode the intensity information for each frequency (wave numbers) and then presents the data as a spectrum.

Protein Residue

Successful recovery of proteins from lithic artifacts relies on the biological activity of those proteins (Hyland et al. 1990:105) and recovery method. Protein residue analysis for lithic artifacts used counter immunoelectrophoresis (CIEP). Both crossover and counter are used in the literature to describe this type of immunoelectrophoresis. This method is based on an antigen-antibody reaction, where a known antibody (immunoglobulin) is used to detect an unknown antigen (Bog-Hansen 1990).

Culliford's (1964, 1971) forensic CIEP methods used at the Royal Canadian Mounted Police Serology Laboratory, Ottawa, and the Centre of Forensic Sciences, Toronto, were modified by Newman and Julig (1989) for use on archaeological materials. Subsequently, PaleoResearch Institute enacted changes following the advice of Dr. Richard Marlar of the Thrombosis Research Laboratory, VA Medical Center, Denver, and the Health Sciences Center, University of Colorado. Although several different protein detection methods have been employed in archaeological analyses, including enzyme-linked immunosorbent assay (ELISA) and radioimmunoassay (RIA), the CIEP test is demonstrated to be extremely sensitive, with the detection of 10^{-8} g of protein possible (Culliford 1964:1092). Testing unknowns against nonimmunized animal serum screens for the presence of reactive proteins that bind indiscriminately with numerous antisera but are not species, genera, family, or group specific. Sediment controls are necessary to address the potential for false positives caused by compounds in sediments, including chlorophyl, bacteria, and metal cations, i.e. manganese, copper, and iron oxide (Evershed et al. 1996), or proteins from modern animal activity, such as feces and urine.

Proteins preserved on stone tools of considerable age have been detected by researchers using CIEP at unrelated institutions (Gerlach et al. 1996; Hogberg et al. 2009; Kooyman et al. 2001; Seeman et al. 2008; Yost and Cummings 2008). For example, Gerlach et al. (1996) report 45 positive reactions obtained on 40 of the 130 stone tools tested from an early North American Paleoindian site (ca. 11,200–10,800 years B.P.). In an archaeological context, an antigen is the unknown protein adhering to an artifact after its use. Although ancient proteins break down into small fragments over time, antibodies can recognize small regions of antigens (Marlar et al. 1995). Sensabaugh et al. (1971:566) demonstrate that proteins undergo chemical and physical modification, breaking down into smaller molecules (polydispersing) and contributing to high molecular weight aggregates of dried blood's insoluble fraction. Hyland et al. (1990:105) hypothesize "protein molecules may be conjoined with fatty tissues, resulting in an insoluble complex" resistant to water's disintegrative properties. Although the mechanism for protein preservation is not fully understood, proteins demonstrate a remarkable ability "to retain a level of biological activity over a long period of time" (Hyland et al. 1990:106). They also demonstrate an affinity for adhering to silica (Marlar et al. 1995), which likely assists with preservation.

The lithics were washed using 0.5–1 ml of solution containing 0.02 m Tris hydrochloride, 0.5 m sodium chloride, and 0.5% Triton X-100 (Tris/NaCl/Triton). While in solution, the artifacts were placed in an ultrasonic bath for 30 minutes, on a rotating mixer for 30 minutes, back into an ultrasonic bath for an additional 30 minutes, and once again onto a rotating mixer for an additional 30 minutes. When removed from the ultrasonic bath, artifacts were rinsed using a small amount of reverse osmosis de-ionized (RODI) water to recover all of the protein wash solution. No sediment control samples accompanied these lithics.

The first step tests all residue washes extracted from artifacts and the sediment controls, when present, against pre-immune goat serum (serum from a nonimmunized animal) to screen for the presence of nonspecific, indiscriminate binding of proteins. All of the artifact washes tested negative against pre-immune serum. Next, the samples were tested against prepared animal and plant antisera obtained from a variety of commercial and private sources (Table H.1). Appropriate positive and negative controls were run for each antiserum. The blood of an animal for which the antiserum tests positively constitutes the positive control, while negative controls use the serum or blood of the type of animal in which the antiserum was raised, either rabbit or goat.

Agarose gel poured onto GelBond® film acts as the medium for CIEP. Four columns of paired wells (2 mm in diameter separated by 3 mm of gel) organized in a series of eight rows were punched into the gel. The anodic (-) well contained the antiserum while the cathodic (+) well held the artifact's protein extraction. The sample was electrophoresed in Barbital buffer (pH 8.6) for 45 minutes at 130 V to drive the antigens and antibodies toward each other. Overnight, a 1 m NaCl bath removed extraneous proteins from the gel. The next morning the gel was pressed for 10 minutes, rinsed with RODI water for an hour, and then pressed for an additional 10 minutes to remove extraneous water and provide a rinse to remove the NaCl. A Fisher Isotemp 500 Series oven at 48ºC finished drying the gel samples.

A positive reaction appears as a vertical line of precipitation between the two wells. Coomassie Blue stain was used to make the line of precipitation easier to see in the gel. When a positive reaction was obtained between the artifact wash (antigen) and an antiserum at the 1:3 dilution, the antigen from the artifact was retested using dilute antiserum at a concentration of 1:5. Retests distinguish between true and false positives, identifying a true positive when they replicate the initial positive reaction. Positive reactions obtained after the second test with dilute antisera are reported.

Many archaeological samples do not produce the expected clear vertical lines of precipitation that are observed with positive blood-based controls. Therefore, descriptions, based on the presence and pattern of precipitation lines, and reaction strengths for each dilution level were recorded to help monitor consistency and viability of the reactions between antisera and archaeological proteins (Table H.2). A recorded "positive" result displays a clear vertical precipitation line between the antiserum and the sample (antigen), indicating the sample wash contained proteins related to the animal represented by the antiserum, or a member of its family group/order. A "very weak positive" demonstrates a faint vertical precipitation line. This suggests presence of deteriorated proteins similar to the antiserum animal's family or order. "Probable positive" samples produce a curved precipitation line or curved concentrated cloud of stain during testing. These reactions suggest the presence of degraded proteins related to the animal represented by the antiserum. However, this reaction cannot be assigned as a definitive positive. Reactions lacking vertical precipitation lines, such as a dense cloud of stain concentrated between the anodic and cathodic wells, are recorded as "questionable positives." These results suggest the sample washes contain proteins but do not definitively identify their presence. If there is no visible reaction, the sample is categorized as "negative," indicating the absence of proteins related to animals represented by the antiserum in the sample wash. All reactions are recorded during testing to better guide retesting. Substantiated positive results are reported.

Table H.1. Antisera used in testing protein residues on lithic artifacts

Antiserum	Source	Possible Results
Mammals:		
Bear	MP Cappel - Fisher	Ursidae (bear family) - *Ursus americana* (black bear), *Ursus arctos* (brown bear and grizzly bear), *Ursus maritimus* (polar bear)
Bison	Prepared under the direction of Dr. Richard Marlar at the University of Colorado Health Sciences Center	*Bison* sp. (bison) - *Bison occidentalis* (prehistoric bison), *Bison bison* (plains bison), *Bison athabascae* (mountain or wood bison); *Bos sp.* (cow), domestic bovids
Bovine	MP Cappel - Fisher	*Bos* sp. (cow), domestic bovids, *Bison* sp. (bison)
Cat	MP Cappel - Fisher	Felidae (cat family) - *Felis concolor* (mountain lion, cougar), *Felis rufus*/ *Lynx rufus* (bobcat), *Felis catus* (domestic cat), and other wild cat species
Deer	MP Cappel - Fisher	Cervidae (deer family) - *Odocoileus hemionus* (mule deer or black-tailed deer), *Odocoileus virginianus* (white-tailed deer), *Cervus canadensis* (elk, wapiti), *Alces alces* (moose), *Rangifer* (caribou)
Dog	MP Cappel - Fisher	Canidae (dog family - coyote, wolf, fox, domestics), *Canis latrans* (coyote), *Canis lupus* (gray wolf), *Canis rufus* (red wolf), *Urocyon cinereoargenteus* (gray fox), *Urocyon littoralis* (island fox), *Vulpes vulpes* (red fox), *Vulpes macrotis* (kit fox), *Vulpes velox* (swift fox), *Canis familiaris* (domestic dog)
Goat	MP Cappel - Fisher	*Antilocapra americana* (pronghorn); *Oreamnos americanus* (mountain goat), *Capra hircus* (domestic goat)
Guinea pig	ImmunO - Fisher	*Castor* sp. (beaver); *Erethizon dorsatum* (porcupine); Sciuridae (rodent family including tree and ground squirrels, flying squirrels, chipmunks, prairie dogs, and marmots/woodchucks) - *Tamias striatus* (eastern chipmunk), *Marmota monax* (woodchuck), *Sciurus carolinensis* (gray squirrel), *Sciurus nigra* (fox squirrel), *Tamiasciurus hudsonicus* (red squirrel), *Glaucomys* sp. (flying squirrel), *Ammospermophilus leucurus* (whitetail antelope squirrel), *Spermophilus* sp./*Citellus* sp. (ground squirrel), *Sciurus griseus* (western grey squirrel); Caviidae (cavy family) - *Cavia porcellus* (guinea pig)
Horse	ICN Pharmaceuticals, Inc.	Equidae (horse family) - *Equus caballus* (horse), *Equus africanus* (donkey), *Equus hippotigris* and *Equus dolichohippus* (zebra), extinct species of wild horse
Human	ICN Pharmaceuticals, Inc.	*Homo sapiens* (human)
Mouse	MP Cappel - Fisher	Members of Cricetidae (family of New World rats and mice, hamsters, and gerbils) and members of Murinae (Old World rats and mice family)
Pig	ICN Pharmaceuticals, Inc.	Suidae (pig family) - *Sus scrofa* (domestic pig and wild pig/boar)
Rabbit	MP Cappel - Fisher	Leporidae (rabbit and jackrabbits/hare family) - *Sylvilagus floridanus* (Eastern cottontail), *Sylvilagus aquaticus* (swamp rabbit or cane-cutter rabbit), *Sylvilagus bachmani* (brush rabbit), *Sylvilagus audubonii* (desert cottontail), *Sylvilagus nuttallii* (mountain cottontail), *Sylvilagus transitionalis* (New England cottontail), *Oryctolagus cuniculus* (European rabbit), *Lepus californicus* (black-tailed jackrabbit), *Lepus townsendii* (white-tailed jackrabbit), *Lepus americanus* (snowshoe hare), *Lepus capensis* (European hare)
Rat	MP Cappel - Fisher	Members of Cricetidae (family of New World rats and mice, hamsters, and gerbils) and members of Murinae (Old World rats and mice family)
Sheep	MP Cappel - Fisher	*Ovis canadensis* (bighorn sheep), *Ovis aries* (domestic sheep)
Birds:		
Chicken	Bethyl	Phasianidae (bird family including chicken, ptarmigan, pheasant, partridge and quail) - *Colinus virginianus* (common bobwhite), *Tympanuchus* (prairie chicken), *Callipepla californica*/*Laphortyx californicus* (California quail), *Callipepla gambelii*/*Lophortyx gambelii* (Gambel's quail), *Oreortyx pictus* (mountain quail); Tetraonidae (grouse family) - *Centrocercus urophasianus* (sage grouse), *Bonasa umbellus* (ruffed grouse); domestic chicken
Turkey	Sigma Chemical Company	Phasianidae (bird family including pheasants, partridges, junglefowl, quail, peafowl, and chickens), *Meleagris gallopavo* (wild turkey) and domestic turkey; Anatidae (duck, geese, and swan family)

Table H.1, continued

Antiserum	Source	Possible Results
Fish:		
American Eel	Robert Sargeant	Anguillidae (freshwater eel family) - *Anguilla rostrata* (American eel)
Atlantic Croaker	Robert Sargeant	Perciformes order (spiny-rayed [percoid] fishes)
Catfish	Sigma Chemical Company	Ictaluridae (catfish family), Cyprinidae (carp and minnow family), Catostomidae (sucker family)
Gizzard Shad	Robert Sargeant	*Dorosoma cepedianum* (gizzard shad); Clupeidae (herring family) - *Alosa aestivalis* (blueback herring), *Alosa mediocris* (hickory shad), *Alosa pseudoharengus* (alewife), *Alosa sapidissima* (American shad), *Brevoortia tyrannus* (Atlantic menhaden), *Clupea harengus* (Atlantic herring), *Etrumeus teres* (round herring), *Harengula jaguana* (scaled sardine), *Opisthonema oglinum* (Atlantic thread herring), and *Sardinella aurita* (Spanish sardine)
Striped Bass	Robert Sargeant	Perciformes order (spiny-rayed [percoid] fish); Percichthyidae (temperate bass), Centrarchidae (sunfish), Percidae (perch), Cottidae (sculpin family), Kyphosidae (sea chubs), Embiotocidae (surfperch and seaperch family), Clinidae (clinids family), Stichaeidae (pricklebacks family), Gobiidae (gobies family), Scombridae (mackerel family), Scorpaenidae (scorpionfish family), Agonidae (poacher family)
Sturgeon	Robert Sargeant	Acipenseridae (sturgeon family) - *Acipenser brevirostrum* (shortnose sturgeon) and *Acipenser oxyrhnchus* (Atlantic sturgeon)
Trout	Sigma Chemical Company	Salmonidae (trout and salmon family) - *Oncorhynchus* (salmon), *Salmo* (trout), *Salvelinus fontinalis* (brook trout), *Salvelinas namaycush* (lake trout), *Coregonus clupeaformis* (lake whitefish), *Prosopium cylindraceum* (round whitefish), *Thymallus arcticus* (arctic grayling), *Oncorhynchus mykiss* (rainbow trout), *Salmo salar* (Atlantic salmon), *Salmo trutta* (brown trout)
Weakfish	Robert Sargeant	Sciaenidae (fish family including drums, croakers, and hardheads) - *Cynoscion regalis* (weakfish)
Plants:		
Yucca	Prepared at PaleoResearch Institute	Yucca, agave, camas, aloe, and all members of the agave and lily families

Table H.2. Categories of likelihood for positive results in protein residue analysis

Reaction Strength	Description	Implications
Positive	A clear vertical line of precipitation between the antiserum and the sample (antigen).	Proteins related to the animal represented by the antiserum, or a member of its family group, are present.
Weak Positive	A clear vertical line of precipitation that is weaker than that observed as a positive reaction.	Proteins from the animal represented by the antisera, or a member of its family group (or order), are present.
Very Weak Positive	A faint vertical line of precipitation.	A few or slightly deteriorated proteins from the animal represented by the antiserum, or a member of its family group (or order), are present.
Probable Positive	A fuzzy, curved line of precipitation adjacent to one of the wells. Line is curved rather than straight and not as clear or defined as with positive reaction between the antiserum and the blood control.	The reaction likely reflects the presence of degraded proteins related to the animal represented by the antiserum, but a definitive positive cannot be assigned.
Questionable Positive	A reaction occurred between the antiserum and sample wash, but no vertical line of precipitation was observed.	It is possible the sample contains proteins related to the animal represented by the antiserum, but the reaction does not definitively identify their presence.
Negative	No visible reaction.	Proteins related to the animal represented by the antiserum are not present.

Identification of animals represented by positive results is usually made to the family level. All mammalian species share serum protein antigenic determinations (epitopes or sites on the surface of an antigen molecule to which the antibody binds); therefore, some crossreactions occur between closely and sometimes distantly related animals (Gaensslen 1983:241). Examples of closely related reactivity include bovine antiserum reacting with bison blood, as well as deer antiserum reacting with other members of the Cervidae (deer) family, such as elk and moose. Positive reactions between distantly related (at the order level) animals include guinea pig antiserum reacting with squirrel blood. This similarity in epitopes (binding sites) is the reason that all labs test their antisera against the blood of many animals, not simply the one to which the antiserum was created. This testing builds lists of animals whose blood is recognized by each antiserum.

ETHNOZOOARCHAEOLOGICAL REVIEW

Ethnographically documented animal uses suggest possible or even probable prehistoric animal exploitation. Similar to ethnobotanic interpretations, records of widespread historic animal utilization may demonstrate continued prehistoric resource practices. However, European contact affected culinary, hunting, and animal use practices, resulting in a loss of indigenous knowledge. A wide breadth of ethnographic sources, both inside and outside the study area, was consulted to permit a more exhaustive review of potential human and animal interactions. Ethnographic literature serves only as a guide, not as conclusive evidence of resources' occurrences or specific uses. When compared with archaeological materials (artifacts and features), protein residues are interpreted as use indicators. We provide the following ethnozooarchaeological background to discuss animals identified through protein residue analysis.

Bovidae (Cattle, Sheep, and Goat Family) and Antilocapridae (Pronghorn Family)

The family Bovidae includes ungulate, ruminant mammals with unbranched horns that grow on all males and sometimes females. Although Bovidae are located primarily in the Old World, bison (*Bison*), goat (*Oreamnos*), sheep (*Ovis*), and muskox (*Ovibos*) are present in North America.

The American bison (*Bison bison*) is the largest terrestrial animal in North America. Bison are found primarily on plains and prairies, in river valleys, and sometimes in forests. The bison's original range included most of the United States, including all of northern Texas. Bison were exceptionally important for Native American peoples of the Plains and woodland prairies. Bison meat supplied a major portion of the diet and shaped hunting customs and food habits for Plains peoples (DeMallie 2001:6). The migratory behavior of bison contributed to the semi- to fully nomadic lifestyle for dependent peoples. Cut and sun-dried, smoked, or salted bison meat kept for several months without spoiling. Also, dried meat was made into pemmican. Tallow and grease were preserved for winter use, and bones and horns provided materials for tools and weapons (Ahler et al. 1991:36). Dried bones and hooves were boiled to make glue. Bison sinew was used for thread and ropes, and hides were used for a variety of products included clothing (garments and shoes), utilitarian items (blankets and cooking vessels), housing (tipi coverings), and even boats. In areas of scarce tree growth, bison droppings (buffalo chips) were used as fuel because they burn easily when dry, providing a hot fire with little smoke. In addition, bison chips were stacked as temporary markers (Dary 1989; Wallis 1947:10-12; Whitaker 1980:664–667).

Leporidae (Rabbit and Jackrabbits/Hare Family)

Leporidae (rabbit and jackrabbit/hare family), including rabbits and hares, are small grazing mammals that generally have long ears, side-facing eyes, long hind legs, soft fur, and short tails. Hares (*Lepus* sp.) are larger than rabbits and prefer open habitats where they can attempt to outrun predators. Jackrabbits tend to inhabit open desert scrubland, prairies, and on occasion woodlands. Rabbits, however, are not as fast and prefer environments with dense cover where they can “freeze” and hide from carnivores (Burt and Grossenheider 1980:202–212; Whitaker 1980:346–364). Cottontail populations thrive in areas with bushy cover as well as poorly drained bottom lands. All of these long-eared jumpers have adapted to a wide range of environments and are found across North America.

Rabbits and jackrabbits (hares) found in central Texas include eastern cottontail (*Sylvilagus floridanus*), desert cottontail (*Sylvilagus audubonii*), swamp rabbit (*Sylvilagus aquaticus*), and black-tailed jackrabbit (*Lepus californicus*) (Burt and Grossenheider 1980:204–212; Texas Tech University 1997; Whitaker 1980:346–364). Ethnographic accounts indicate rabbits were among the smaller game animals pursued by the Tonkawa (Newcomb and Campbell 2001:957).

Fish (Ichthyes)

Fish are a commonly exploited source of protein throughout time and across the world. They are present in most bodies of water and exhibit extreme species diversity. Families common in the lakes, rivers, and streams of central Texas include Acipenseridae, Moronidae, Percidae, and Salmonidae. Fish antisera tested against the samples included Atlantic croaker (Sciaenidae), catfish (Ictaluridae), gizzard shad (Clupeidae), striped bass (Moronidae along with other Perciformes), sturgeon (Acipenseridae), trout (Salmonidae), and weakfish (Sciaenidae and other Perciformes).

Numerous fish species inhabit the river systems of Texas including sturgeon (Acipenseridae); bowfin (Amiidae); American eel (Anguillidae); bass, crappie, and sunfishes (Centrarchidae); cichlid (Cichlidae); shad (Clupeidae); carp and minnows (Cyprinidae); pickerel (Esocidae); catfish and bullheads (Ictaluridae); gars (Lepisosteidae); walleye (Percidae); paddlefish (Polyodontidae); trout (Salmonidae); and drum (Sciaenidae) (Klym and Garrett 2002; Texas Parks and Wildlife 2014). The Tonkawa of north and east-central Texas caught fish using hook-and-line and spear techniques (Newcomb and Campbell 2001:957}.

Anguillidae (Freshwater Eel Family)

Anguilla rostrata (American eel) is a freshwater eel with small scales embedded in the skin. After reaching sexual maturity, they migrate to the Atlantic Ocean to spawn. Research indicates that only females ascend rivers, where they can remain for a number of years (Boschung 1983:375–376).

DISCUSSION

The Jayroe site (41HM51) is a campsite that exhibits two temporal components: a predominant Late Prehistoric Toyah phase occupation that rests at the top of a buried paleosol and an ephemeral Late Archaic occupation deep within the paleosol (John Dockall, personal communication, May 1, 2017). The Toyah occupation dates mostly, if not entirely, to the A.D. 1400s.

Situated in Hamilton County, Texas, at the edge of a terrace overlooking the Leon River approximately 40 m to the south, this site "lies within the Lampasas Cut Plain at the northeastern margins of the Balconian biotic province, near its boundary with the Texan and Kansan biotic provinces" (Broehm and Kibler 2004:3). The rugged topography of this area includes "broad, rolling bottomlands, separated by often steeply sloping, flat top hills and ridges (Blair 1950:112–113; Johnson 1931:125)" (Broehm and Kibler 2004:3). Local vegetation includes pecan (*Carya illinoinensis*) and American sycamore (*Platanus occidentalis*) trees and an understory of unidentified grasses, while vegetation in the Balconian biotic province is characterized by Mexican cedar (*Cupressus lusitanica*), Texas oaks (*Quercus* sp.), live oaks (*Quercus* sp.), and mesquites (*Prosopis* sp.). Live oaks, elms (*Ulmus*), hackberries (*Celtis*), and pecans are particularly abundant in floodplains (Broehm and Kibler 2004:3).

The site features three pit hearths, four earth ovens with burned rocks, and eight debris concentrations containing burned rocks, mussel shells, animal bones, and/or lithic artifacts, along with an extensive scatter of nonfeature lithic and ceramic artifacts. Fourteen Toyah phase stone tools were submitted: 5 ground or battered stone tools (an anvil, a thick slab fragment, a mano fragment, and 2 hammerstones) and 9 chipped stone tools (a chopper/chopping tool, 2 end scrapers, 2 bifacial knives, 2 flake tools, and 2 Perdiz arrow points) (Table H.3). Additionally, 7 ceramic sherds were submitted. Organic residue analysis using Fourier Transform Infrared Spectroscopy (FTIR) was conducted on the ceramic sherds and ground or battered stone tools, while protein analysis was conducted on the chipped stone tools.

FTIR Analysis

Seven of the ceramic sherds are identified as possibly representing Vessel 1. One punctated rim sherd, represented by Sample 130, is identified as representing Vessel 2. A plain neck sherd, represented by Sample 469, is assigned to Vessel 3. FTIR analyses of residue samples from these sherds points to similarities in many of the signatures.

Table H.3. Provenience data for residue analysis samples

Sample No.	Feature	Unit	Elevation (m)	Provenience/Description	Analysis
482		EU 88	97.80–97.70	Vessel 1, incised body sherd	FTIR
385		EU 63	98.00–97.90	Vessel 1, incised sherd	FTIR
386		EU 63	97.90–97.80	Vessel 1?, incised body sherd	FTIR
122-2, 122-3		TU 18	97.93–97.83	Vessel 1?, brushed body sherd	FTIR
125-1	8	TU 17	97.69	Vessel 1?, undecorated base sherd	FTIR
130		TU 19	97.83–97.73	Vessel 2, punctated rim sherd	FTIR
469		EU 85	97.80–97.70	Vessel 3, plain neck sherd	FTIR
423-1		EU 73	97.80–97.70	Anvil	FTIR
470-2	13	EU 85	97.80–97.70	Thick slab fragment	FTIR
595-1		EU 121	98.30–98.20	Mano end fragment	FTIR
618-1		EU 133	97.70–97.60	Hammerstone	FTIR
561-1		EU 11	98.60–98.50	Hammerstone	FTIR
549-1		EU 107	98.40–98.30	Chopper/chopping tool	Protein
363-4		EU 57	98.20–98.10	End scraper	Protein
558-3		EU 110	98.70–98.60	End scraper	Protein
474-2		EU 86	97.80–98.60	Bifacial knife	Protein
562-1		EU 111	98.50–98.40	Bifacial knife	Protein
366-1		EU 58	98.20–98.10	Flake tool	Protein
341-2		EU 52	98.30–98.20	Flake tool	Protein
240-1		EU 27	98.00–97.90	Perdiz arrow point	Protein
506-1		EU 94	97.70–97.60	Perdiz arrow point	Protein

Our FTIR reference signature for bison bone marrow exhibits very strong peaks in the functional group region at approximately 2916 and 2849 cm^{-1}, accompanied by small "side" peaks at approximately 2955 and 2871 cm^{-1}. A very strong peak at approximately 1741 cm^{-1}, accompanied by a smaller "side" peak at approximately 1728 cm^{-1} represents Omega 3 oils. Strong, sharp peaks at approximately 1464, 1173, and 720 cm^{-1} also were observed. Rule of three peaks for saturated esters were observed at 1741; 1195 and 1173; and 1104, 1097, 1060, and 1036 cm^{-1}. FTIR signatures of plants and animals containing high levels of Omega 3 oils exhibit similar patterns of peaks. The peak between 1690 and 1735 cm^{-1} represents a carbonyl, while the double peaks between 3000 and 2800 cm^{-1} represent the -CH stretch in fats, lipids, oils, and plant waxes.

Three incised sherds possibly representing Vessel 1, Samples 482, 385, and 386, exhibit peaks in the functional group region (3000–2800 cm^{-1}) and peaks in both the saturated and aromatic ester fingerprint regions (Table H.4). Samples 385 and 386 exhibit similar signatures in that the major peaks in the upper range of the saturated esters (1750–1730 cm^{-1}) are situated near 1736 or 1729 and 1703/02 cm^{-1}. Sample 482, however, exhibits its peaks at 1740 and 1699 cm^{-1}, with the latter being the highest amplitude. It is very likely that the peak at 1699 cm^{-1} is part of the saturated ester complex of peaks and is simply shifted from its expected location, creating a higher amplitude signature similar to the one noted in Sample 386 and a signature very similar to that observed in Sample 122-3, a brushed body sherd also possibly from Vessel 1, where the highest peak is noted at 1700 cm^{-1}, with a "side or shoulder" peak observed at 1735 cm^{-1}. The base sherd that may be from Vessel

1,Sample 125-1, does not exhibit this pattern of saturated ester peaks, although it displays the requisite peaks between 3000 and 2800 cm^{-1}, accompanied by a broader low amplitude peak that varies from 1735 to 1733 cm^{-1}. This portion of the FTIR signature matches well with our reference signature from bison bone marrow.

Additional moderate to high amplitude Omega 3 fatty acid peaks are observed at 1464 and 1173 cm^{-1} in the bison bone marrow sample. Peaks at 1470 and/or 1464/63 cm^{-1} are observed in the four samples representing the incised and brushed body sherds that might be associated with Vessel 1. Again, the base sherd exhibits a different signature that includes a peak at 1463 or 1459 cm^{-1} probably representing Omega 3 fatty acids.

This signature strongly suggests use of Vessel 1 (or all of the vessels represented by these sherds if they do not represent the same vessel) for processing bone marrow, presumptively bison bone marrow. In addition, these five sherd samples exhibited peaks typical of proteins. Sample 385 exhibited the least complex set of peaks suggesting proteins.

The similarity in FTIR signatures for the ranges 3000–2800 and 1730–1700 cm^{-1} from Sample 130 suggests that Vessel 2 also was used to process bone marrow. This sample also yielded peaks typical of proteins.

Sample 469 representing Vessel 3 yielded peaks typical of fats and saturated esters. However, the peak at 1730 cm^{-1} typically associated with saturated esters also falls within the range of hemicellulose, a group that includes plant structural molecules. This is important because this sample also yielded peaks between 1237 and 1228 cm^{-1}, which also suggest hemicellulose. Phospholipids, which are expected to accompany saturated esters, peak at 1224 cm^{-1}, and this range of peaks (1237 to 1228 cm^{-1}) is a little too far removed to be considered representative of phospholipids. Therefore, Vessel 3 is interpreted to have had a different use than Vessels 1 and 2. Hemicellulose might derive from fuel wood or perhaps from carbohydrate-rich plants cooked or boiled in this vessel.

Five samples representing an anvil, a thick slab fragment, a mano end fragment, and two hammerstones exhibit signatures more diverse from one another (Table H.5). The anvil, Sample 423-1, exhibits moderately high peaks in the fats/lipids range (3000–2800 cm^{-1}), as well as all three required peaks representing saturated esters and the required three peaks plus one peak indicating aromatic esters. Peaks in the appropriate range for proteins also were noted. This signature is not a good fit for bison bone marrow, which suggests this tool was used while pounding or grinding something different, possibly meat for pemmican.

The FTIR signature obtained for the thick slab, Sample 470-2, again indicates the presence of fats and proteins. All three requisite peaks are present to indicate saturated esters, but not aromatic esters. This signature provides evidence of fats/lipids, proteins, and carbohydrates. Several amino acids including alanine, gluatamate, leucine, lysine, phenalanine, and serine are suggested in this sample as they were in the anvil sample. Peaks in the carbohydrate range suggest the presence of several polysaccharides and cell wall constituents such as pectin.

Table H.4. FTIR peak summary for the sherd samples

Peak Range	Represents	Vessel 1, incised body	Vessel 1, incised	Vessel 1?, incised body	Vessel 1?, brushed body	Vessel 1?, base	Vessel 2, punctated rim	Vessel 3, plain neck
		Sample 482	Sample 385	Sample 386	Sample 122-2, 122-3	Sample 125-1	Sample 130	Sample 469
Fats/Oils/Lipids/Plant Waxes:								
3000–2800	Aldehydes:fats, oils, lipids, waxes	2955/54, 2915/14, 2871, 2849/48/47	2955/54, 2915, 2872/71, 2848	2955/54, 2916/15, 2871, 2849	2955, 2915/14, 2872/71, 2849/48	2955/53, 2921/20, 2871/70, 2852/51/50	2955/54, 2918, 2850, 2870	2963, 2955, 2923/22, 2853/52
1742	Triglycerides (C=O Stretch)	1743/40						
1737 1224	Phospholipids (C=O Stretch) (P=O)	1736, 1223/20	1734/33/29, 1237/36/24	1736	1736/35, 1222/18/16	1735/33	1223	1735/30, 1228
1377	Fats, oils, lipids, humates (CH_3 symmetric bend)	1377/76		1377		1375/65	1377	
1170	Lipids						1171	
Lipids: Saturated Esters:								
1750–1730 Rule of Three	Saturated esters (C=O Stretch)	1743/40, 1736	1734/33/29	1736, 1729/28	1736/35, 1730/29	1735/33		1735/30
1210–1160 Rule of Three	Saturated esters	1204, 1195, 1186, 1177	1187/86	1197/96/95 1178/77	1204, 1195, 1185, 1176	1164/61/59	1205, 1171, 1164/63	
1100–1030 Rule of Three	Saturated esters	1105/02/01, 1033	1103/02	1101/1099/96 1032/31	1102, 1088/87, 1059, 1033/32		1074, 1034	1092
1188	Saturated ester C-C-O	1186	1187/86		1185			
1094	Saturated ester O-C-C							1092
1028	Ester O-C-C stretch			1032/31			1025/24	
Lipids: Aromatic Esters:								
1730–1705 Rule of Three	Aromatic esters (C=O Stretch)		1734/33/29, 1703/01/ 1699	1729/28, 1706/04/02	1730/29, 1704/01/00		1707/06/02	1735/30
1310–1250 Rule of Three	Aromatic esters	1312/11, 1296, 1287, 1278, 1262/59	1312, 1297/96	1270/69, 1259	1303/00, 1296, 1286, 1278, 1259/56		1278, 1260, 1251/49	
1130–1100 Rule of Three	Aromatic esters	1123/20, 1105/02/01	1122/21/19, 1103/02	1101/ 1099/96	1119/14		1114	1122/17/15
750–700 Rule of Three +1	Aromatic esters	727, 717	727, 720	720/19/16		723/20/19	722/21/19	727

Table H.4, continued

Peak Range	Represents	Vessel 1, incised body	Vessel 1, incised	Vessel 1?, incised body	Vessel 1?, brushed body	Vessel 1?, base	Vessel 2, punctated rim	Vessel 3, plain neck
		Sample 482	Sample 385	Sample 386	Sample 122-2, 122-3	Sample 125-1	Sample 130	Sample 469
1238	Aromatic ether C-O stretch	1240	1237/36/24			1238/35/33		1237/30/28
1604, 1602, 1586, 1497, 1362	Aromatic ring mode			1604/02		1375/65	1609/04	
1453	Aromatic ring mode						1456	
699–697, 692	Aromatic ring bend			689			696/94	
763, 760, 745, 737,736	Aromatic out-of-plane C-H bend	760	761/760		760/59		759/57/53	
Proteins:								
1700–1350	Protein	1700/1699, 1577, 1541, 1470, 1464, 1429, 1414/12, 1390, 1377/76, 1354/48	1703/01/ 1699, 1578/77, 1540/39, 1471/70, 1463, 1431, 1412/09, 1371/70	1706/04/02 1604/02, 1512/10, 1466/64/63, 1431/30, 1391/90, 1377	1704/01/00, 1580/76, 1540, 1471/70, 1464/63, 1430, 1416/15, 1390, 1348/47	1632/28, 1577/74, 1543/39, 1463/59, 1375/65	1707/06/02, 1669, 1626, 1609/04, 1578/75, 1540/38, 1511/07, 1464/63, 1456, 1434/31/30, 1414/12/10, 1377	1656, 1610, 1463, 1434/33/32 1372/70/69
1653	Proteins (Amide bands, 80% C=O Stretch, 10% C-N Stretch, 10% N-H Bend)							1656
1660–1655	Proteins, Nucleic acids							1656
1465–1455	Protein/lipids	1464	1463	1466/64/63	1464/63	1463/59	1464/63, 1456	1463
3500–3300 sharp	Amide A			3348		3369/64	3355	
3300–3100	Amide B, N–H Stretch					3229/28		
1243	Amide C-N stretch	1240			1247/46/41			
Protein: Amino Acids								
1465	Alanine CH_2 bending	1464	1463	1466/64/63	1464/63		1464/63	1463
1608, 1586	Arginine Benzene ring vibrations						1609/04	1610
1415	Glutamate CO_2^- symmetric stretching	1414/12		1413/11	1416/15/12		1414/12/10	

Table H.4, continued

Peak Range	Represents	Vessel 1, incised body Sample 482	Vessel 1, incised Sample 385	Vessel 1?, incised body Sample 386	Vessel 1?, brushed body Sample 122-2, 122-3	Vessel 1?, base Sample 125-1	Vessel 2, punctated rim Sample 130	Vessel 3, plain neck Sample 469
1375	Leucine CH_3 symmetric bending	1377/76		1377		1375/65	1377	
1640–1610, 1550–1485,	Lysine (amino acid) NH_3^+ bending	1541	1540/39	1512/10	1540	1632/28, 1543/39	1626, 1609/04, 1540/38	1610
1602, 1450, 760, 700	Phenylalanine Benzene ring vibrations	760	761/60	1604/02	760/59		1609/04, 759/57/53	
1350–1250	Serine O-H bending	1354/48, 1331/30, 1312/11, 1296, 1287, 1278, 1262/59	1331/30/28, 1312, 1297/96	1331/30, 1270/69, 1259	1348/47, 1332/31, 1303/00, 1296, 1286, 1278, 1259/56		1278, 1260, 1251/49	
1600, 1450	Tyrosine Benzene ring vibrations			1604/02				
Carbohydrates (General):								
1170–1150, 1059, 1050, 1033vs, 1030	Cellulose	1033		1032/31	1059, 1033/32	1164/61/59	1171, 1164/63, 1034	
1120	Ether C-O stretch, Cellulose	1123/20	1122/20/19		1119/14			1122/17/15
1028–1000	Cellulose Carbohydrates	1016/11	1021/20/17	1032/31	1015	1007/993/92	1025/24	1021/19
796	Deteriorated cellulose		798/94	797/96		794	798/94	794/93
1732, 1240	Hemicellulose		1734/33/29, 1237/36/24	1729/28	1730/1729, 1247/46/41	1735/33, 1238/35/33		1735/30, 1237/30/28
1590, 1510	Lignin			1512/1510				
Above 1510 (close)	Lignins, softwood, Aromatic skeletal bands			1512/1510			1511/07	
Below 1510	Lignins, hardwood, Aromatic skeletal bands						1511/07	
Carbohydrates: Polysaccharides:								
807	Arabinan	809/04						804
880	Arabinogalactan	890/81						
1074	Arabinogalactan						1074	
879	Arabinogalactan (Type II)	890/81						
892	Arabinogalactan (Type II)				892/91/90			

Table H.4, continued

		Vessel 1, incised body	Vessel 1, incised	Vessel 1?, incised body	Vessel 1?, brushed body	Vessel 1?, base	Vessel 2, punctated rim	Vessel 3, plain neck
Peak Range	Represents	Sample 482	Sample 385	Sample 386	Sample 122-2, 122-3	Sample 125-1	Sample 130	Sample 469
1034	Arabinogalactan (Type II) + Glucomannan (9:1, w/w), Glucomannan-vs	1033		1032/31	1033/32		1034	
1161, 1151	Arabinoglucuronoxylan + Galactoglucomannan					1164/61/59	1164/63	
881	Arabinoglucuronoxylan + Galactoglucomannan	890/81						
1072vs	Galactan						1074	
893	Galactan				892/91/90			
883	Galactan	890/81						
1122	Rhamnogalacturonan	1123/20	1122/20/19					1122/17/15
846	Rhamnogalacturonan	849						
1034vs, 960	Galactoglucomannan	1033		1032/31	1033/32, 959/53		1034, 958	
934	Galactoglucomannan	940/39/32						
1680–1600, 1260, 1022vs, 972, 955, 953, 891	Pectin	1262/59, 1105/02/01, 890/81	1103/02, 2012/20/17	1604/02, 1259, 1101/1099/ 96	1259/56, 1102, 959/53, 892/91/90	1632/28	1669, 1626, 1609/04, 1260, 2025/24	1656, 1610, 1021/19
1104	Glucan, Pectin-vs	1105/02/01	1103/02		1102			
1041, 1026vs	Glucan						1025/24	
1092, 1064vs	Glucomannan							1092
941	Glucomannan	940/39/32	943/42	941	940/39		944/42	945/44/43
850	Methyl β-D-glucopyranoside	849						
1084	Glucuronoxylan (GX)				1088/87			
1118	Xyloglucan	1123/20	1122/20/19		1119/14			1122/17/15
945	Xyloglucan		943/42				944/42	945/44/43
1026vs, 8580	Starch	849					1025/24	
Other:								
1626,	Chitin (C=H Stretching of N-acetyl group)					1632/28	1626	

vs = Very Strong band; s = Strong band; vs or s next to a number applies to that number; vs or s to the left of two numbers applies to both; vs or s next to a compound applies only to that compound at that specific wave number.

Table H.5. FTIR peak summary for ground and battered stone samples

		Anvil	Thick slab fragment	Mano end fragment	Hammerstone	Hammerstone
Peak Range	Represents	Sample 423-1	Sample 470-2	Sample 595-1	Sample 618-1	Sample 561-1
Fats/Oils/Lipids/Plant Waxes:						
3010	Lipids (=C-H Stretch)					3008
1170	Lipids	1172/67				
1377	Fats, oils, lipids, humates (CH_3 symmetric bend)	1377	1378/77		1377	1378/77
3000–2800	Aldehydes: fats, oils, lipids, waxes	2957/54/53, 2919/18, 2872, 2851/50	2955/54, 2917/16, 2871, 2850/49	2929/21, 2871	2959/53, 2924/20/19, 2871, 2853/51	2958, 2922/21, 2855/52
1742	Triglycerides (C=O Stretch)					1740/38
1737 1224	Phospholipids (C=O Stretch) (P=O)	1737	1737/36, 1221/17			1740/38
Lipids: Saturated Esters:						
1750–1730 Rule of Three	Saturated esters (C=O Stretch)	1737, 1729	1737/36, 1730			1740/38
1210–1160 Rule of Three	Saturated esters	1195, 1172/67	1200/1195, 1177, 1163/57	1160		1162/60
1100–1030 Rule of Three	Saturated esters	1100, 1052, 1034/29/27	1098, 1030/26	1083, 1034/32	1100, 1088	1048, 1033
1028	Ester O-C-C stretch	1034/29/27	1030/26			
Lipids: Aromatic Esters:						
1730–1705 Rule of Three	Aromatic esters (C=O Stretch)	1729, 1713/09	1730, 1708/02			
1310–1250 Rule of Three	Aromatic esters	1270/67	1296, 1277, 1270/69, 1259/56		1247	1267
1130–1100 Rule of Three	Aromatic esters	1113, 1100			1100	
750–700 Rule of Three +1	Aromatic esters	721/20, 711	719/18/17	730, 711/10		744, 720
763, 760, 745, 737, 736	Aromatic out-of-plane C-H bend			762		744

Table H.5, continued

Peak Range	Represents	Anvil	Thick slab fragment	Mano end fragment	Hammerstone	Hammerstone
		Sample 423-1	Sample 470-2	Sample 595-1	Sample 618-1	Sample 561-1
1604, 1602, 1586, 1497, 1362	Aromatic ring mode	1606/05	1605/04			
699–697, 692	Aromatic ring bend					691/89
Proteins:						
1700–1350	Protein	1638/37, 1629, 1606/05, 1579, 1545/42, 1516/10, 1466/64, 1416/14, 1409, 1377, 1366	1638/37, 1625, 1605/04, 1581/78, 1540/38, 1466/64/63, 1430, 1416/09, 1378/77	1626, 1579, 1535, 1390/89, 1364	1625/19/11, 1546, 1466/60, 1419	1639, 1623, 1609, 1538/36, 1510, 1464/63, 1434, 1411/10, 14011378/77
1465–1455	Protein/lipids	1466/64	1466/64/63		1466/60	1464/63
3500–3300 sharp	Amide A	3365/64, 3327/25/24	3338	3366/60	3327	3392, 3377/76, 3350, 3308
3300–3100	Amide B, N–H Stretch		3221	3267	3271, 3222	3272/67/63, 3187/86
1243	Amide C-N stretch	1245	1241			1242
Proteins: Amino Acids:						
1465	Alanine CH_2 bending	1466/64	1466/64/63		1466/60	1464/63
1608, 1586	Arginine Benzene ring vibrations	1606/05				1609
1415	Glutamate CO_2^- symmetric stretching	1416/14	1416/1409			
1615	Glutamine, NH_2 Bend				1625/19/11	
1375	Leucine CH_3 symmetric bending	1377	1378/77		1377	1378/77
1640–1610, 1550–1485,	Lysine (amino acid) NH_3^+ bending	1638/37, 1629, 1545/42, 1516/10	1638/37, 1625, 1540/38	1626, 1535	1625/19/11, 1546	1639, 1623, 1609, 1538/36, 1510

Table H.5, continued

Peak Range	Represents	Anvil	Thick slab fragment	Mano end fragment	Hammerstone	Hammerstone
		Sample 423-1	Sample 470-2	Sample 595-1	Sample 618-1	Sample 561-1
1602, 1450, 760, 700	Phenylalanine Benzene ring vibrations	1606/05	1605/04	762		
1350–1250	Serine O-H bending	1323, 1270/67	1331, 1313, 1296, 1277, 1270/69, 1259/56		1247	1267
Carbohydrates (General):						
1590, 1510	Lignin	1516/10				
Above 1510	Lignins, softwood, Aromatic skeletal bands	1516/10				1510
Below 1510	Lignins, hardwood, Aromatic skeletal bands					1510
1170–1150, 1050, 1030	Cellulose	1172/67, 1050, 1034/29/27	1163/57, 1030/26	1160, 1034/32		1162/60, 1048, 1033
1059, 1033vs	Cellulose		1030/26			1033
1028–1000	Cellulose Carbohydrates	1034/29/27	1030/26, 1005	1021		1007
1732, 1240	Hemicellulose	1729	1730, 1241			1242
796	Deteriorated cellulose		796/93			794
Carbohydrates: Monosaccharides:						
915, 840	α-D-glucose			918	839	
915, 900	β-D-glucose			918		
900, 845	Methyl α-D-glucopyranoside			844		
Carbohydrates: Polysaccharides:						
1097	Arabinan		1098			
918	Arabinan			918	921	
1045	Arabinogalactan					1048
1043, 985	Arabinogalactan					986
868	Arabinogalactan	870		870/69		
842	Arabinogalactan			844		

Table H.5, continued

Peak Range	Represents	Anvil	Thick slab fragment	Mano end fragment	Hammerstone	Hammerstone
		Sample 423-1	Sample 470-2	Sample 595-1	Sample 618-1	Sample 561-1
1156 (Type II)	Arabinogalactan (Type II)		1163/57			
916	Arabinogalactan (Type II), Glucan			918		
1034	Arabinogalactan (Type II) + Glucomannan (9:1, w/w), Glucomannan-vs	1034/29/27		1034/32		1033
872	Arabinogalactan (Type II) + Glucomannan (9:1, w/w), Glucomannan, Galactoglucomannan	870		870/69		
1049vs	Arabinogalactorhamnoglycan	1052				1048
914	Arabinogalactorhamnoglycan		911			
837	Arabinogalactorhamnoglycan				839	
1161, 1151	Arabinoglucuronoxylan + Galactoglucomannan		1163/57	1160		1162/60
1034vs, 960	Galactoglucomannan	1034/29/27		1034/32, 963		1033
1043, 989	Rhamnogalacturonan					986
951, 916	Rhamnogalacturonan			918	953	
846	Rhamnogalacturonan			844		
840	Glucan				839	
1041, 1026vs	Glucan		1030/26			
941	Glucomannan		941	938	938	
1084	Glucuronoxylan (GX)			1083		
1047, 985	Glucuronoxylan (GX)					1048, 986
1155	Galactan, Starch		1163/57			
1110	Starch	1113				
1082	Starch			1083		
1026vs	Starch	1034/29/27	1030/26			
1680–1600, 1260, 955	Pectin	1638/37, 1629, 1606/05	1638/37, 1625, 1605/04, 1259/56	1626	1625/19/11, 953	1639, 1623, 1609
1100**vs**	Pectin	1100			1100	

Table H.5, continued

Peak Range	Represents	Anvil	Thick slab fragment	Mano end fragment	Hammerstone	Hammerstone
		Sample 423-1	Sample 470-2	Sample 595-1	Sample 618-1	Sample 561-1
1082, 1051	Pectin	1052		1083		1048
1047, 1017vs(1017 only)	Pectin					1048
1022vs, 972	Pectin			1021		
1004vs	Pectin		1005			1007
953	Pectin				953	
910, 869, 850	β-D-sucrose	870	911	870/69		
916, 908	β-D-cellulose		911	918		
Minerals:						
1620	Calcium oxalate (must also have 1317/15 and 780)				1625/19/11	1623
1317, 1315	Calcium oxalate		1313			
1577, 1539 - both	Calcium oleate	1579, 1545/1542	1581/78, 1540/38			1538/36
1420, 873, 712	$CaCO_3$ (requires all 3 peaks, 873/2, 712)	873, 711		870/69, 711/10	1419	
872	$CaCO_3$	870		870/69		
Other:						
1626,	Chitin (C=H Stretching of N-acetyl group)	1629	1625	1626	1625/19/11	1623
2974, 2968, 2965, 2962, 2956, 2872	CH_3 Asymmetric Stretch	2957/54/53, 2872	2955/54, 2871	2871	2959/53, 2924/20/19, 2871	2958
2959, 2938, 2936, 2934, 2931, 2930, 2926, 2924, 2922	CH_2 Asymmetric stretch	2957/54/53, 2919/18		2929/21	2959/53, 2924/20/19	2958, 2922/21
2879, 2875, 2873, 2871, 2870	CH_3 Symmetric stretch	2872	2871	2871	2871	
2876, 2872, 2863, 2858, 2855	CH_2 Symmetric stretch	2872	2871	2871	2871, 2853/51	2855/52
830	Symmetric C-C-O stretch				828	
1394, 1379, 1366	Split CH3 umbrella mode, 1:2 intensity	1377, 1366	1378/77	1364		1378/77
1384, 1364	Split CH3 umbrella mode, 1:1 intensity	1366		1364		

Table H.5, continued

Peak Range	Represents	Anvil	Thick slab fragment	Mano end fragment	Hammerstone	Hammerstone
		Sample 423-1	Sample 470-2	Sample 595-1	Sample 618-1	Sample 561-1
1386, 1385, 1381/80/79	CH_3 Umbrella mode	1377	1378/77			
1375	CH_3 Umbrella mode	1377			1377	1378/77
1238	Aromatic ether C-O stretch		1241			
1202	Tertiary alcohol C-O stretch		1200/1195			
1095	Saturated ether C-O stretch		1098			
1019	Primary alcohol CH_2-O stretch			1021		
993, 910, 718, 640	Alkene out-of-plane C-H bend	721/20	993, 719/18/17			720
914	C-C-C Stretch		911			
1000–900		964/61	993, 941, 911	963, 938, 918	953, 938, 921	986
~960	Aluminum dish	964/61		963		
722–719	CH_2 Rock (methylene)	721/20	719/18/17			720

vs = Very Strong band; s = Strong band; vs or s next to a number applies to that number; vs or s to the left of two numbers applies to both; vs or s next to a compound applies only to that compound at that specific wave number.

The mano fragment yielded a single dominant peak at 1390/1389 cm^{-1} suggesting the presence of proteins. This peak appears to have migrated to 1364 cm^{-1} in the upper portion of the drying dish, still representing proteins. A sharp peak at 3360 cm^{-1} represents amides, also present in meat. Although peaks suggesting the presence of cellulose and pectin also were observed, this mano appears to have been used to grind meat, possibly for making pemmican. It is difficult to interpret the limited peaks suggesting carbohydrates as indicating grinding any particular plant. Pollen analysis is a much better indicator of grinding plants.

The two hammerstones yielded signatures different from each other. Sample 561-1 exhibited peaks indicating the presence of fats/lipids, but those peaks were very low amplitude in Sample 618-1. Both hammerstones yielded a rounded peak suggesting the presence of water. Protein or chitin is indicated in Sample 618-1. Protein and carbohydrates are suggested for Sample 561-1.

Protein Residue Analysis

The chopper/chopping tool, Sample 549-1, yielded a questionable positive reaction to bovine antiserum at both the 1:3 and 1:5 dilutions suggesting the possibility that bison was processed (Table H.6). It also yielded a positive reaction at the 1:5 dilution to rabbit antiserum indicating it had been used to process rabbits. It is not unusual to have a favorite tool that one uses on more than one type of animal. One bifacial knife, Sample 474-2, also yielded a positive reaction to rabbit antiserum at the 1:5 dilution. This sample also yielded a very weak positive reaction, at the 1:5 dilution, to American eel antiserum suggesting it might have been used to process eels, which were more abundant in Texas prior to construction of dams. None of the other seven chipped stone tools yielded a definitive positive reaction to the antisera against which they were tested. Questionable positive reactions to fish antiserum were common, though, occurring in five of the samples. This suggests the probability that local sediments contain fish proteins. Due to the ubiquity of the responses at a questionable level, they are not interpreted to represent use of these tools.

Table H.6. Positive protein residue results for lithic tools

Sample No.	Description	Dilution	Positive Result (Antiserum Type)	Possible Animal(s) Represented	Reaction Strength
549-1	Chopper/ chopping tool	1:3 1:5	Bovine	Cow, domestic bovids, bison	Questionable positive
		1:3	Rabbit	Eastern cottontail, desert cottontail, black-tailed jackrabbit	Probable positive
		1:5			Positive
474-2	Bifacial knife	1:3	Rabbit	Eastern cottontail, desert cottontail, black-tailed jackrabbit	Probable positive
		1:5			Positive
		1:3	American eel	American eel	Probable positive
		1:5			Very weak positive

Genus and species listed for each family or order group do not comprise an exhaustive list. Instead, they are examples that react positively to the antiserum listed. Reactions are observed at more general levels than genus, meaning that all species of a genus have the same reaction potential.

SUMMARY AND CONCLUSIONS

Organic residue analysis using FTIR to examine ceramic vessel sherds and ground or battered lithic tools identified bone marrow processing using Vessels 1 and 2. Vessel 3 appears to have been used to cook carbohydrates or plant remains, as the fats/lipids peaks are present only as low amplitude peaks. The anvil and thick slab both yielded FTIR signatures typical of processing fats and proteins, suggesting use to crack marrow bones and perhaps to process meat. The mano fragment yielded peaks typical of proteins suggesting processing or grinding meat, perhaps to make pemmican. Further identification of the significance of the peaks representing cellulose and pectin might be obtained from pollen and starch analysis. The two hammerstones yielded peaks representing proteins. Only the hammerstone represented by Sample 561-1 exhibited peaks typical of fats/lipids and suggesting the presence of carbohydrates. The hammerstone represented by Sample 618-1 yielded a rounded peak typical of water. Protein residues found on two of the nine flaked tools indicate processing of rabbit, possibly American eel, and possibly bison.

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APPENDIX I: Metric Data for Stone Tools

John E. Dockall

APPENDIX I: Metric Data for Stone Tools

Lot	Specimen	Group	Type	Portion	Material	Max. Length	Max. Width	Max. Thickness	Weight (g)	Stem Length	Stem Width	Neck Thickness	Neck Width
542	3	Arrow	Cuney	Proximal-medial	Chert		16.2	2.3	0.7	8.05	6.25	2.35	5.51
691	1	Arrow	Harrell/ Washita	Distal-medial	Chert			4.1	1.1			2.81	8.35
346	2	Arrow	Perdiz	Stem	Chert	12.3	7.6	3.0	0.3				
445	4	Arrow	Perdiz	One barb missing	Chert	23.9		2.8	0.6	8.86	4.89	2.31	4.68
502	5	Arrow	Perdiz	Complete	Chert	25.3	15.2	3.0	0.8	8	1.75	2.92	6.04
410	3	Arrow	Perdiz	Distal-medial	Chert			2.9	1.1			2.33	6.37
230	1	Arrow	Perdiz	Proximal-medial	Chert			2.6	0.8	11.33	2.09	2.37	6.04
358	1	Arrow	Perdiz	Complete	Chert	23.6	13.6	2.6	0.6	5.68	2.16	2.16	5.45
358	2	Arrow	Perdiz	Proximal-medial	Chert		21.0	3.3	1.1	8.43	5.62	2.22	6.83
358	3	Arrow	Perdiz	Distal-medial	Chert		20.7	3.7	1.1		4.66	3.03	5.07
189	2	Arrow	Perdiz	Proximal-medial	Chert		18.4	4.2	1.2	9.14	3.49	3.96	6.18
250	1	Arrow	Perdiz	Medial	Chert			2.2	0.7			1.97	7.2
240	1	Arrow	Perdiz	Distal	Chert		20.7	2.6	1.3			2.04	6.59
183	2	Arrow	Perdiz	Medial	Chert		18.4	2.9	0.8			2.73	6.48
168	1	Arrow	Perdiz	Distal	Chert			4.2	1.1			3.04	5.97
254	1	Arrow	Perdiz	One barb missing	Chert	36.0		3.6	1.6	14.16	3.44	3.2	7.92
370	1	Arrow	Perdiz	Distal	Chert			2.8	0.7				
370	2	Arrow	Perdiz	Barb/shoulder	Chert				0.3				
378	1	Arrow	Perdiz	Medial	Chert			3.4	0.7				
262	3	Arrow	Perdiz	One barb missing	Chert	31.8		3.1	1.0	9.79	3.15	2.36	4.95
262	4	Arrow	Perdiz	One barb missing	Chert	30.2		3.0	1.3	8.67	4.24	2.3	5.75
262	5	Arrow	Perdiz	Proximal-medial	Chert		18.5	3.2	0.7	9.95	3.89	2.15	7.05
242	5	Arrow	Perdiz	Complete	Chert	27.0	15.1	3.9	1.1	6.74	3.33	2.51	7.14
375	6	Arrow	Perdiz	Distal-medial	Chert			3.8	1.2			2.59	5.85
274	3	Arrow	Perdiz	Complete	Chert	34.5	16.8	3.4	1.4	12.08	3.28	3.23	5.85
274	4	Arrow	Perdiz	One barb missing	Chert	21.5		2.5	0.5	6.97	3.04	1.96	5.01
447	2	Arrow	Perdiz	Proximal-medial	Chert		18.7	2.6	0.9			1.96	6.79
322	1	Arrow	Perdiz	Proximal-medial	Chert		20.1	3.2	1.1	11.72	2.86	2.3	5.32
455	8	Arrow	Perdiz	Distal-medial	Chert			2.3	0.5			1.97	5.32
457	1	Arrow	Perdiz	Proximal-medial	Chert		20.9	3.4	0.9	10.08	3.58	2.78	6.26
470	1	Arrow	Perdiz	Complete	Chert	28.7	17.4	2.9	0.8	10.45	3.39	2.77	6.19
495	1	Arrow	Perdiz	Distal-medial	Chert		16.6	3.3	1.3			2.56	6.65
506	1	Arrow	Perdiz	Distal-medial	Chert			3.3	1.3			2.72	6.09
549	4	Arrow	Perdiz	One barb missing	Chert	24.9		2.7	0.8	8.63	4.69	2.29	6.78
603	1	Arrow	Perdiz	Proximal-medial	Chert			2.9	1.0			2.98	7.86
604	1	Arrow	Perdiz	One barb missing	Chert	27.7	19.9	3.7	1.3	7.63	3.44	2.51	4.99
622	2	Arrow	Perdiz	Distal	Chert		18.0	2.9	1.3			2.71	5.88

Appendix I, continued

Lot	Specimen	Group	Type	Portion	Material	Max. Length	Max. Width	Max. Thickness	Weight (g)	Stem Length	Stem Width	Neck Thickness	Neck Width
290	1	Arrow	Perdiz	One barb missing	Chert	36.1		3.8	1.9	10.25	3.21	2.72	5.98
290	2	Arrow	Perdiz	Complete	Chert	1.1	13.4	1.9	0.2	7.89	3.17	1.74	5.6
363	3	Arrow	Perdiz	Stem/barb	Chert				0.3	14.19	3.69	2.79	6.49
130	1	Arrow	Perdiz	Lateral edge(s) missing	Chert			2.9	0.9			2.18	6.54
116	1	Arrow	Perdiz	Distal-medial	Chert		17.8	2.2	0.6			1.85	5.57
127	1	Arrow	Perdiz	Proximal-medial	Chert			3.1	1.1	13.95	3.91	2.81	8.37
60	1	Arrow	Perdiz	Distal-medial	Chert		17.8	3.0	1.0			2.49	5.9
576	2	Arrow	Perdiz	Medial	Chert			2.9					
502	4	Arrow	Scallorn	One barb missing	Chert	35.7		2.5	1.3	8.22		2.26	7.02
310	1	Arrow	Scallorn	Complete	Chert	38.4	19.2	5.4	2.7	9.32	19.01	4.43	11.72
561	2	Arrow		Distal	Chert	10.6	9.3	3.0	0.3				
394	4	Arrow		Stem/barb	Chert								
546	1	Arrow		Proximal-medial	Chert		11.6	1.8	0.3			1.61	5.16
210	1	Arrow		Proximal-medial	Chert			2.2	0.6	7.97	3.24	1.77	5.16
173	1	Arrow		Distal	Chert			2.1	0.4				
261	1	Arrow		Distal	Chert			1.9	0.2				
289	1	Arrow		Proximal	Chert		6.3	2.6	0.1				
299	4	Arrow		Barb/shoulder	Chert		5.4	2.4	0.1				
304	2	Arrow		Distal	Chert		12.7	2.5	0.3				
338	1	Arrow		Distal	Chert		14.1	3.1	0.6				
341	1	Arrow		Distal	Chert		22.3	12.1	0.7				
341	5	Arrow		Barb/shoulder	Chert				0.2				
341	6	Arrow		Fragment	Chert				0.6				
381	1	Arrow		Distal	Chert				0.4				
407	1	Arrow		Fragment	Chert				0.1				
429	2	Arrow		Distal	Chert				0.1				
433	1	Arrow		Fragment	Chert				0.2				
534	1	Arrow		Distal	Chert			1.9	0.3				
555	3	Arrow		Distal	Chert			3.3	1.8				
614	3	Arrow		Distal	Chert				0.3				
692	1	Arrow		Barb/shoulder	Chert				0.2				
122	1	Arrow		Distal	Chert			3.2	1.2				
555	2	Arrow		Medial	Obsidian		15.8	2.1				1.84	6.4
221	1	Arrow		Distal	Obsidian			2.5					
455	7	Arrow preform	Perdiz	Proximal-medial	Chert		14.9	2.2	0.8	7.11	3.98	2.24	6.86
182	2	Arrow preform	Perdiz	Proximal-medial	Chert		19.4	3.4	1.0	5.77	4.39	2.1	8.94
278	2	Arrow preform	Perdiz	Proximal-medial	Chert		19.0	2.6	0.9	7.19	2.86	2.35	5.99
169	3	Arrow preform	Perdiz	Proximal-medial	Chert		24.5	2.8	2.3	14.31	3.9	2.46	7.87
207	2	Arrow preform	Perdiz	Proximal-medial	Chert		22.8	3.4	1.6	7.16	4.67	2.11	11.56
286	6	Arrow preform	Perdiz	Proximal-medial	Chert	26.4	21.0	4.7	2.1	6.25	3.77	3.23	10.77
342	1	Arrow preform	Perdiz	Complete	Chert	38.8	24.8	5.0	3.1	9.65	3.2	4.2	11.71
447	1	Arrow preform	Perdiz	Proximal	Chert		21.4	5.7	2.1				

Appendix I, continued

Lot	Specimen	Group	Type	Portion	Material	Max. Length	Max. Width	Max. Thickness	Weight (g)	Stem Length	Stem Width	Neck Thickness	Neck Width
553	3	Arrow preform	Perdiz	Proximal-medial	Chert		23.6	4.2	2.7	5.73	5.39	3.49	8.47
553	2	Arrow preform	Perdiz	Complete	Chert	32.9		4.3	2.2	8.18	3.88	2.59	7.57
576	1	Arrow preform	Perdiz	Proximal-medial	Chert		22.0	4.3	2.2	7		3.33	8.4
623	1	Arrow preform	Perdiz	Complete	Chert	45.2	24.5	5.5	5.7	5.79	3.42	2.92	9.84
286	3	Arrow preform		Distal	Chert	25.2	24.1	3.2	2.0				
295	1	Arrow preform		Proximal	Chert	19.0	26.7	3.8	2.4				
299	1	Arrow preform		Complete	Chert	32.9	18.1	4.2	3.0				
336	2	Arrow preform		Complete	Chert	40.9	21.2	3.5	2.9				
346	1	Arrow preform		Proximal	Chert	21.3	23.1	3.3	1.1				
506	4	Arrow preform		Indeterminate	Chert	27.1	25.5	2.8	2.0				
290	3	Arrow preform		Proximal-medial	Chert			3.0	1.0	5.95	3.31	5.62	9.53
165	2	Arrow preform		Distal	Chert			2.6	0.9				
178	1	Arrow preform		Complete	Chert	34.9	21.1	6.0	3.2				
207	1	Arrow preform		Distal	Chert	22.1	19.0	3.4	1.3				
226	1	Arrow preform		Distal	Chert		17.3	2.9	1.1				
249	1	Arrow preform		Proximal-medial	Chert	26.3	28.4	4.5	3.9				
328	2	Arrow preform		Distal	Chert		15.8	3.5	0.8				
381	2	Arrow preform		Distal	chert				0.6				
506	3	Arrow preform		Distal	Chert			2.8	1.0				
553	1	Arrow preform		Distal	Chert			3.3	1.5				
556	1	Arrow preform		Complete	Chert	40.2	26.1	6.4	7.2				
558	4	Arrow preform		Proximal-medial	Chert		22.9	5.9	3.4				
617	1	Arrow preform		Distal	Chert			3.2	0.6				
625	2	Arrow preform		Fragment	Chert				0.3				
706	3	Arrow preform		Complete	Chert	40.5	25.2	5.5	5.2				
605	1	Dart	Darl	Complete	Chert	50.5	19.3	7.1	7.1	16.69	16.35	6.49	16.01
62	1	Dart	Ensor	Proximal-medial	Chert		42.9	7.7	6.9	10.59	19.07	5.43	12.87
161	1	Bifacial knife, beveled		Medial	Chert	20.3	31.7	7.0	7.8				
262	2	Bifacial knife, beveled		Distal	Chert	40.6	32.2	8.1	11.7				
336	3	Bifacial knife, beveled		Medial	Chert	48.6	54.1	6.5	23.2				
445	1	Bifacial knife, beveled		Fragment	Chert	30.2	27.4	7.2	4.7				
474	2	Bifacial knife, beveled		Complete	Chert	68.2	40.9	6.6	23.0				
539	1	Bifacial knife, beveled		Proximal-medial	Chert	51.6	37.4	7.5	13.8				
549	2	Bifacial knife, beveled		Distal	Chert	32.6	23.8	5.6	4.1				
557	4	Bifacial knife, beveled		Proximal	Chert	39.5	48.3	7.2	11.6				
562	1	Bifacial knife, beveled		End	Chert	73.3	36.7	5.8	17.9				

Appendix I, continued

Lot	Specimen	Group	Type	Portion	Material	Max. Length	Max. Width	Max. Thickness	Weight (g)	Stem Length	Stem Width	Neck Thickness	Neck Width
648	1	Bifacial knife, beveled		Distal	Chert	70.1	40.0	6.8	20.0				
659	1	Bifacial knife, beveled		Distal	Chert	27.2	28.4	5.0	4.7				
212	1	Bifacial knife, beveled		Fragment	Chert	14.8	18.9	4.7	1.1				
148	2	Biface, knife		Distal	Chert	28.6	34.4	5.5	5.0				
229	1	Biface, knife		Proximal	Chert	61.2	54.4	7.0	27.4				
230	3	Biface, knife		Proximal	Chert	60.6	52.5	6.5	19.3				
247	1	Biface, knife		Proximal	Chert	27.6	36.6	4.6	9.8				
401	1	Biface, knife		Medial	Chert	32.4	38.9	4.0	7.0				
502	2	Biface, knife		Indeterminate	Chert	32.9	26.6	6.1	5.9				
566	1	Biface, knife		Medial	Chert	40.9	26.2	5.9	9.8				
571	3	Biface, knife		Distal	Chert	17.4	23.2	5.1	1.5				
183	1	Biface, Stage 1		Medial	Chert	45.1	49.2	13.8	34.5				
456	1	Biface, Stage 1		Complete	Chert	42.4	35.2	10.3	15.6				
456	3	Biface, Stage 1		Complete	Chert	42.2	29.5	7.2	11.0				
78	1	Biface, Stage 1		Complete	Chert	49.9	29.5	11.7	18.3				
61	1	Biface, Stage 1		Complete	Chert	34.4	39.8	10.6	13.8				
100	1	Biface, Stage 1		Proximal	Chert	29.5	33.5	9.6	9.7				
147	1	Biface, Stage 2		Proximal-medial	Chert	37.8	28.9	7.3	8.1				
164	1	Biface, Stage 2		Proximal-medial	Chert	33.7	30.3	6.9	9.0				
182	1	Biface, Stage 2		Proximal	Chert	34.9	54.0	10.1	27.2				
242	2	Biface, Stage 2		Proximal	Chert	31.3	32.5	7.5	7.8				
246	3	Biface, Stage 2		Complete	Chert	54.7	34.7	8.2	16.8				
336	1	Biface, Stage 2		Fragment	Chert	38.0	10.9	5.1	2.0				
372	1	Biface, Stage 2		Complete	Chert	49.1	31.9	7.1	7.8				
442	1	Biface, Stage 2		Complete	Chert	57.7	34.2	35.4	12.3				
553	4	Biface, Stage 2		Complete	Chert	65.1	46.0	14.9	37.9				
562	2	Biface, Stage 2		Fragment	Chert	48.3	28.1	6.9	12.4				
571	2	Biface, Stage 2		Complete	Chert	33.2	28.4	8.9	8.8				
211	2	Biface, Stage 3		Fragment	Chert	24.1	28.1	6.5	4.2				
366	2	Biface, Stage 3		Lateral edge(s) missing	Chert	38.1	28.1	6.0	6.8				
426	1	Biface, Stage 3		Distal	Chert	33.2	19.1	6.5	3.3				
455	5	Biface, Stage 3		Fragment	Chert	21.5	20.4	3.9	1.7				
591	3	Biface, Stage 3		Complete	Chert	46.9	30.8	31.6	10.8				
542	2	Biface, Stage 4		Medial	Chert	7.3	17.7	3.7	0.5				
113	1	Biface, Stage 4		Fragment	Chert	37.9	27.7	7.1	9.5				
242	1	Biface fragment, burin retouch		Indeterminate	Chert	45.3	27.3	7.8	9.1				
258	3	Biface fragment, burin retouch		Indeterminate	Chert	43.9	21.4	8.3	9.9				

Appendix I, continued

Lot	Specimen	Group	Type	Portion	Material	Max. Length	Max. Width	Max. Thickness	Weight (g)	Stem Length	Stem Width	Neck Thickness	Neck Width
651	4	Biface fragment, burin retouch		Indeterminate	Chert	39.4	27.3	7.8	8.9				
230	2	Biface, indeterminate		Complete	Chert	37.6	25.2	8.3	7.2				
234	2	Biface, indeterminate		Complete	Chert	50.7	28.8	11.7	17.9				
238	1	Biface, indeterminate		Lateral edge(s) missing	Chert	49.9	29.3	8.0	10.5				
271	1	Biface fragment, radial break		Fragment	Chert	23.5	22.2	6.8	4.3				
182	3	Biface, indeterminate fragment		Indeterminate	Chert	12.5	20.9	6.1	1.2				
217	2	Biface, indeterminate fragment		Fragment	Chert	35.9	23.2	6.8	4.5				
278	3	Biface, indeterminate fragment		Indeterminate	Chert	19.3	30.1	6.3	3.0				
282	1	Biface, indeterminate fragment		Indeterminate	Chert	35.9	28.5	9.8	6.9				
296	1	Biface, indeterminate fragment		Fragment	Chert	33.9	22.2	7.5	5.6				
299	3	Biface, indeterminate fragment		Fragment	Chert	34.1	16.4	5.3	2.9				
309	4	Biface, indeterminate fragment		Indeterminate	Chert	6.2	18.5	3.7	0.4				
375	5	Biface, indeterminate fragment		Fragment	Chert	17.8	12.6	5.4	1.2				
437	1	Biface, indeterminate fragment		Fragment	Chert	30.5	16.8	4.6	1.6				
455	6	Biface, indeterminate fragment		Fragment	Chert	22.8	19.6	8.4	3.3				
456	2	Biface, indeterminate fragment		Indeterminate	Chert	21.6	24.6	5.9	2.4				
572	1	Biface, indeterminate fragment		Fragment	Chert	25.2	26.7	6.1	4.3				
577	1	Biface, indeterminate fragment		Fragment	Chert	9.3	18.0	3.9	0.7				

Appendix I, continued

Lot	Specimen	Group	Type	Portion	Material	Max. Length	Max. Width	Max. Thickness	Weight (g)	Stem Length	Stem Width	Neck Thickness	Neck Width
614	2	Biface, indeterminate fragment		Fragment	Chert	42.4	32.9	9.5	10.8				
686	1	Biface, indeterminate fragment		Fragment	Chert	25.8	17.4	5.5	2.3				
113	3	Biface, indeterminate fragment		Fragment	Chert	32.8	15.2	5.1	2.9				
245	2	Uniface, convex end scraper		Distal	Chert	51.4	31.1	20.7	22.1				
251	1	Uniface, convex end scraper		Complete	Chert	46.5	28.5	8.2	9.9				
257	1	Uniface, convex end scraper		Complete	Chert	59.8	35.7	10.1	24.9				
273	1	Uniface, convex end scraper		Distal	Chert	34.6	47.8	9.3	16.1				
286	4	Uniface, convex end scraper		Complete	Chert	25.1	15.7	2.6	1.3				
286	5	Uniface, convex end scraper		Complete	Chert	44.4	25.3	6.9	10.1				
342	3	Uniface, convex end scraper		Complete	Chert	47.0	38.7	15.5	28.9				
363	1	Uniface, convex end scraper		Distal	Chert	25.4	35.6	8.4	9.3				
363	4	Uniface, convex end scraper		Complete	Chert	83.3	54.1	34.9	131.1				
370	3	Uniface, convex end scraper		Complete	Chert	43.2	20.3	6.0	5.8				
375	8	Uniface, convex end scraper		Complete	Chert	45.4	35.5	12.9	20.1				
410	2	Uniface, convex end scraper		Complete	Chert	50.5	25.7	10.3	13.8				
430	2	Uniface, convex end scraper		Complete	Chert	62.9	42.1	16.4	33.5				
558	3	Uniface, convex end scraper		Complete	Chert	59.3	42.8	14.0	34.2				
575	1	Uniface, convex end scraper		Distal-medial	Chert	54.8	27.2	9.6	18.2				
685	1	Uniface, convex end scraper		Complete	Chert	87.8	34.2	16.5	37.2				
711	1	Uniface, convex end scraper		Complete	Chert	62.2	44.2	17.1	27.0				
341	8	Uniface, end/ side scraper		Complete	Chert	65.4	34.4	13.2	25.7				
590	1	Uniface, side scraper		Complete	Chert	63.3	32.0	8.9	20.1				
591	2	Uniface, side scraper		Complete	Chert	51.2	43.7	5.2	14.9				

Appendix I, continued

Lot	Specimen	Group	Type	Portion	Material	Max. Length	Max. Width	Max. Thickness	Weight (g)	Stem Length	Stem Width	Neck Thickness	Neck Width
375	3	Uniface, end scraper		Distal	Chert	24.0	32.6	6.4	5.2				
650	1	Uniface, spokeshave		Complete	Chert	35.1	17.6	3.5	2.4				
101	1	Uniface, beaked tool		Complete	Chert	54.3	39.4	25.6	46.7				
181	1	Uniface, indeterminate		Distal	Chert	51.2	41.8	10.8	26.6				
223	1	Uniface, indeterminate		Complete	Chert	60.3	47.1	17.4	33.3				
333	2	Uniface, indeterminate		Distal	Chert	48.2	43.7	7.2	19.8				
695	2	Uniface, indeterminate		Lateral edge(s) missing	Chert	52.9	32.5	10.2	16.0				
517	1	Uniface resharpening flake		Complete	Chert	29.8	22.9	5.9	2.9				
267	1	Uniface fragment with radial break		Fragment	Chert	25.7	23.8	9.9	4.2				
299	2	Uniface fragment with radial break		Distal	Chert	10.1	22.1	3.3	0.8				
557	2	Uniface fragment with radial break		Proximal	Chert	27.9	44.5	10.2	11.6				
669	1	Uniface fragment with radial break		Fragment	Chert	27.1	21.0	8.4	3.5				
710	2	Uniface fragment with radial break		Proximal-medial	Chert	48.5	30.8	12.2	19.4				
242	3	Uniface fragment with snap break		Complete	Chert	51.9	43.3	5.8	15.0				
558	1	Uniface fragment with snap break		Proximal	Chert	36.3	42.4	11.4	17.1				
591	1	Uniface fragment with snap break		Distal	Chert	31.3	47.2	8.5	13.8				
683	1	Uniface fragment with snap break		Fragment	Chert	40.2	22.3	7.0	5.2				
706	2	Uniface fragment with snap break		Complete	Chert	46.8	38.1	17.3	31.1				
162	2	Drill		Proximal-medial	Chert	37.0	29.2	10.1	8.0				
226	3	Drill		Distal	Chert	15.2	7.3	3.8	0.5				
250	2	Drill		Proximal-medial	Chert	64.6	51.3	8.7	20.3				

Appendix I, continued

Lot	Specimen	Group	Type	Portion	Material	Max. Length	Max. Width	Max. Thickness	Weight (g)	Stem Length	Stem Width	Neck Thickness	Neck Width
278	4	Drill		Distal	Chert	23.4	5.3	3.2	0.5				
341	3	Drill		Distal	Chert	14.4	6.2	2.9	0.4				
342	2	Drill		Proximal	Chert	24.4	26.0	4.4	2.9				
390	1	Drill		Proximal-medial	Chert	25.7	28.3	4.4	2.9				
531	1	Drill		Distal	Chert	19.2	8.1	3.0	0.5				
574	1	Drill		Proximal	Chert	16.6	22.0	6.8	1.8				
179	1	Perforator		Proximal-medial	Chert	29.5	13.7	3.0	1.1				
227	1	Perforator		Complete	Chert	36.2	17.0	4.1	1.9				
502	1	Perforator		Proximal-medial	Chert	31.2	19.0	3.0	1.4				
688	1	Perforator		Complete	Chert	17.0	11.6	2.9	0.4				
606	2	Flake tool, graver		Complete	Chert	15.87	9.59	1.81	0.25				
606	1	Flake tool, graver		Distal	Chert	37.3	29.2	8.1	7.2				
549	1	Chopping tool		Complete	Chert	64.9	57.8	23.0	95.7				
333	1	Flake tool, Indeterminate		Complete	Chert	39.9	25.9	8.0	7.4				
147	2	Flake tool, Indeterminate		Distal-medial	Chert	37.7	29.1	4.1	3.5				
147	3	Flake tool, Indeterminate		Proximal-medial	Chert	25.5	19.9	2.8	1.8				
156	2	Flake tool, Indeterminate		Complete	Chert	20.0	19.1	3.5	1.2				
164	2	Flake tool, Indeterminate		Proximal-medial	Chert	33.7	15.9	5.6	3.5				
169	2	Flake tool, Indeterminate		Fragment	Chert	26.0	17.7	2.7	1.4				
227	2	Flake tool, Indeterminate		Distal	Chert	22.5	12.2	3.4	0.6				
230	5	Flake tool, Indeterminate		Fragment	Chert	17.4	10.5	2.9	0.6				
242	4	Flake tool, Indeterminate		Fragment	Chert	25.2	13.5	4.3	1.2				
246	2	Flake tool, Indeterminate		Proximal	Chert	25.2	33.1	4.9	4.9				
251	2	Flake tool, Indeterminate		Medial	Chert	17.8	22.5	2.5	1.2				
258	1	Flake tool, Indeterminate		Complete	Chert	33.0	27.0	4.0	3.6				
258	2	Flake tool, Indeterminate		Proximal	Chert	33.9	21.2	5.1	3.7				
270	2	Flake tool, Indeterminate		Fragment	Chert	31.0	27.7	5.3	3.5				
277	1	Flake tool, Indeterminate		Proximal-medial	Chert	32.6	35.9	3.1	4.1				
279	1	Flake tool, Indeterminate		Proximal	Chert	28.5	27.3	5.7	5.0				

Appendix I, continued

Lot	Specimen	Group	Type	Portion	Material	Max. Length	Max. Width	Max. Thickness	Weight (g)	Stem Length	Stem Width	Neck Thickness	Neck Width
283	1	Flake tool, Indeterminate		Complete	Chert	42.8	37.5	6.3	7.7				
286	1	Flake tool, Indeterminate		Distal	Chert	30.9	32.5	4.0	4.8				
333	3	Flake tool, Indeterminate		Complete	Chert	50.5	56.8	14.9	40.3				
350	1	Flake tool, Indeterminate		Medial	Chert	24.0	22.5	2.8	2.5				
350	2	Flake tool, Indeterminate		Complete	Chert	36.3	29.9	4.5	5.0				
448	1	Flake tool, Indeterminate		Indeterminate	Chert	12.0	28.7	4.0	1.6				
455	2	Flake tool, Indeterminate		Fragment	Chert	29.5	16.1	3.3	2.3				
465	2	Flake tool, Indeterminate		Medial	Chert	24.0	16.0	3.6	1.5				
571	1	Flake tool, Indeterminate		Proximal-medial	Chert	30.1	34.2	4.3	5.1				
577	2	Flake tool, Indeterminate		Medial	Chert	21.9	12.1	4.3	0.9				
582	1	Flake tool, Indeterminate		Complete	Chert	46.8	38.6	5.0	8.5				
625	1	Flake tool, Indeterminate		Fragment	Chert	27.7	14.2	2.8	1.1				
648	2	Flake tool, Indeterminate		Fragment	Chert	29.6	19.0	3.9	2.0				
86	1	Flake tool, Indeterminate		Complete	Chert	44.5	25.1	7.1	7.8				
286	2	Flake tool, Indeterminate		Medial	Chert	18.3	24.9	5.7	3.3				
334	1	Flake tool, Indeterminate		Fragment	Chert	15.9	21.7	5.9	1.6				
410	1	Flake tool, Indeterminate		Fragment	Chert	19.6	15.2	3.8	1.2				
447	3	Flake tool, Indeterminate		Proximal-medial	Chert	51.1	27.1	7.6	9.9				
589	1	Flake tool, Indeterminate		Fragment	Chert	63.3	41.1	18.2	47.0				
706	4	Flake tool, Indeterminate		Complete	Chert	53.5	52.7	8.5	30.6				
148	1	Flake tool, Indeterminate		Distal-medial	Chert	59.9	26.5	9.4	14.2				
169	1	Flake tool, Indeterminate		Proximal	Chert	29.8	41.0	7.7	7.5				
185	1	Flake tool, Indeterminate		Distal	Chert	41.1	25.4	5.8	7.5				
187	1	Flake tool, Indeterminate		Distal	Chert	25.1	30.8	4.2	3.3				

Appendix I, continued

Lot	Specimen	Group	Type	Portion	Material	Max. Length	Max. Width	Max. Thickness	Weight (g)	Stem Length	Stem Width	Neck Thickness	Neck Width
189	1	Flake tool, Indeterminate		Proximal	Chert	24.0	20.2	4.0	2.7				
193	1	Flake tool, Indeterminate		Proximal	Chert	22.0	31.4	6.3	3.5				
234	1	Flake tool, Indeterminate		Proximal	Chert	22.3	23.8	4.3	2.4				
300	1	Flake tool, Indeterminate		Complete	Chert	61.8	37.6	4.7	19.4				
301	1	Flake tool, Indeterminate		Distal-medial	Chert	46.3	28.8	6.9	7.4				
309	3	Flake tool, Indeterminate		Medial	Chert	24.0	26.0	3.5	2.6				
328	1	Flake tool, Indeterminate		Complete	Chert	49.0	40.9	9.0	17.6				
354	1	Flake tool, Indeterminate		Fragment	Chert	26.8	21.3	8.1	4.6				
363	2	Flake tool, Indeterminate		Distal	Chert	20.7	12.2	5.2	1.1				
377	2	Flake tool, Indeterminate		Fragment	Chert	48.0	24.4	7.7	6.5				
384	1	Flake tool, Indeterminate		Fragment	Chert	13.6	22.9	4.3	1.2				
430	1	Flake tool, Indeterminate		Fragment	Chert	18.0	5.2	3.5	0.3				
608	1	Flake tool, Indeterminate		Distal	Chert	52.1	37.4	8.7	11.2				
622	1	Flake tool, Indeterminate		Medial	Chert	37.5	22.8	6.3	5.2				
148	3	Flake tool, Indeterminate		Complete	Chert	60.0	39.7	7.7	12.9				
159	2	Flake tool, Indeterminate		Complete	Chert	53.6	40.6	9.2	19.5				
159	1	Flake tool, Indeterminate		Complete	Chert	48.4	36.7	8.1	15.1				
162	1	Flake tool, Indeterminate		Complete	Chert	59.2	35.0	16.9	33.0				
195	1	Flake tool, Indeterminate		Complete	Chert	50.6	35.0	8.3	14.0				
216	1	Flake tool, Indeterminate		Complete	Chert	41.0	23.8	8.6	6.1				
230	4	Flake tool, Indeterminate		Complete	Chert	42.1	30.3	3.6	6.7				
246	1	Flake tool, Indeterminate		Complete	Chert	48.9	19.9	6.6	5.8				
247	2	Flake tool, Indeterminate		Proximal-medial	Chert	42.4	32.9	9.0	9.3				
328	3	Flake tool, Indeterminate		Complete	Chert	53.5	19.9	6.1	7.2				

Appendix I, continued

Lot	Specimen	Group	Type	Portion	Material	Max. Length	Max. Width	Max. Thickness	Weight (g)	Stem Length	Stem Width	Neck Thickness	Neck Width
341	2	Flake tool, Indeterminate		Complete	Chert	58.0	41.4	10.2	19.8				
345	3	Flake tool, Indeterminate		Complete	Chert	28.7	34.5	9.5	10.1				
365	1	Flake tool, Indeterminate		Complete	Chert	58.2	28.6	11.8	14.6				
366	1	Flake tool, Indeterminate		Complete	Chert	62.9	30.8	8.2	15.5				
371	1	Flake tool, Indeterminate		Proximal-medial	Chert	37.4	22.7	4.6	3.8				
375	1	Flake tool, Indeterminate		Distal	Chert	32.9	19.2	3.4	2.0				
375	7	Flake tool, Indeterminate		Medial	Chert	16.9	26.6	7.3	3.2				
377	1	Flake tool, Indeterminate		Distal	Chert	26.5	22.0	6.0	2.9				
380	1	Flake tool, Indeterminate		Complete	Chert	48.8	27.0	8.5	7.9				
394	2	Flake tool, Indeterminate		Medial	Chert	16.6	29.3	4.8	2.9				
469	2	Flake tool, Indeterminate		Complete	Chert	45.5	20.1	5.8	5.1				
469	3	Flake tool, Indeterminate		Proximal	Chert	22.2	25.5	5.1	2.7				
469	4	Flake tool, Indeterminate		Proximal	Chert	28.4	37.6	6.1	7.3				
502	3	Flake tool, Indeterminate		Distal	Chert	37.7	34.2	7.8	8.2				
549	3	Flake tool, Indeterminate		Complete	Chert	50.0	38.8	7.5	19.0				
555	1	Flake tool, Indeterminate		Proximal	Chert	31.6	36.8	6.4	97.2				
556	2	Flake tool, Indeterminate		Medial	Chert	16.7	27.1	6.1	3.4				
558	2	Flake tool, Indeterminate		Distal	Chert	25.2	31.7	5.5	3.2				
569	1	Flake tool, Indeterminate		Distal-medial	Chert	35.0	38.0	7.9	12.3				
615	1	Flake tool, Indeterminate		Distal	Chert	22.0	20.4	7.5	4.0				
655	1	Flake tool, Indeterminate		Complete	Chert	44.7	31.3	12.0	10.0				
685	2	Flake tool, Indeterminate		Distal	Chert	38.0	34.2	7.0	10.4				
698	2	Flake tool, Indeterminate		Complete	Chert	62.3	41.6	15.3	40.0				
710	1	Flake tool, Indeterminate		Complete	Chert	54.8	26.4	10.6	12.2				

Appendix I, continued

Lot	Specimen	Group	Type	Portion	Material	Max. Length	Max. Width	Max. Thickness	Weight (g)	Stem Length	Stem Width	Neck Thickness	Neck Width
591	4	Flake tool, Indeterminate		Fragment	Chert	25.2	39.7	7.9	7.8				
695	1	Flake tool, Indeterminate		Complete	Chert	45.0	33.0	7.3	13.0				
220	1	Flake tool with burin retouch		Fragment	Chert	35.1	35.0	14.1	16.5				
557	1	Flake tool with burin retouch		Complete	Chert	44.8	31.4	9.5	13.3				
651	3	Flake tool with burin retouch		Indeterminate	Chert	32.0	27.9	12.3	9.8				
634	1	Burin spall		Distal	Chert	16.7	4.7	3.9	0.3				
114	1	Burin spall		Complete	Chert	56.9	12.4	5.4	4.1				
87	1	Hammerstone			Orthoquartzite	74.7	65.9	32.9	212.0				
757	1	Hammerstone			Orthoquartzite	45.2	28.9	28.5	43.2				
618	1	Hammerstone			Orthoquartzite	76.1	44.0	47.6	239.4				
474	1	Hammerstone			Orthoquartzite	52.4	41.8	29.5	89.0				
152	1	Hammerstone			Limestone	42.2	38.3	38.9	90.9				
549	5	Hammerstone			Limestone	59.2	53.3	33.8	401.0				
401	2	Hammerstone			Limestone				42.3				
561	1	Hammerstone			Orthoquartzite	110.3	86.7	65.8	800.0				
423	1	Anvil			Limestone	75.6	76.1	58.3	500.0				
553	5	Slab			Sandstone	72.0	60.9	20.9	131.5				
470	2	Slab			Sandstone	88.7	68.0	28.6	245.9				
364	1	Slab			Sandstone	71.5	71.9	21.4	183.1				
604	2	Slab			Sandstone	72.0	45.0	22.9	118.5				
450	1	Mano			Sandstone	63.8	56.7	51.0	262.5				
370	4	Mano			Sandstone	83.7	79.6	26.8	232.1				
595	1	Mano			Sandstone	69.5	74.8	39.8	332.4				
569	2	Polishing stone			Orthoquartzite	67.1	55.0	18.5	103.4				
756	1	Indeterminate ground stone			Ironized sandstone				16.4 (n = 3)				
344	1	Indeterminate ground stone			Limestone				21.6				
111		Pigment source			Ocher, hematite, limonite	14.8	15.0	9.4	2.4				
162		Pigment source			Ocher, hematite, limonite				7.8 (n = 2)				
165		Pigment source			Ocher, hematite, limonite				0.5				
182		Pigment source			Ocher, hematite, limonite				0.1				
255		Pigment source			Ocher, hematite, limonite				5.5				
262		Pigment source			Ocher, hematite, limonite				0.6				

Appendix I, continued

Lot	Specimen	Group	Type	Portion	Material	Max. Length	Max. Width	Max. Thickness	Weight (g)	Stem Length	Stem Width	Neck Thickness	Neck Width
271		Pigment source			Ocher, hematite, limonite				2.5				
273		Pigment source			Ocher, hematite, limonite				0.2				
283		Pigment source			Ocher, hematite, limonite				1.3				
305		Pigment source			Ocher, hematite, limonite				1.3 (n = 2)				
323		Pigment source			Ocher, hematite, limonite				0.7				
325		Pigment source			Ocher, hematite, limonite				9.8				
328		Pigment source			Ocher, hematite, limonite				1.1 (n = 2)				
386		Pigment source			Ocher, hematite, limonite				4.4				
410		Pigment source			Ocher, hematite, limonite				0.2				
458		Pigment source			Ocher, hematite, limonite				1.0				
472		Pigment source			Ocher, hematite, limonite				6.9				
492		Pigment source			Ocher, hematite, limonite				0.4				
502		Pigment source			Ocher, hematite, limonite				0.3				
518		Pigment source			Ocher, hematite, limonite				5.2				
542		Pigment source			Ocher, hematite, limonite				0.5				
585		Pigment source			Ocher, hematite, limonite				0.7 (n = 2)				
590		Pigment source			Ocher, hematite, limonite				1.7				
591		Pigment source			Ocher, hematite, limonite				1.2				
625		Pigment source			Ocher, hematite, limonite				4.1 (n = 2)				
662		Pigment source			Ocher, hematite, limonite				0.5				
677		Pigment source			Ocher, hematite, limonite				5.2 (n = 4)				
692		Pigment source			Ocher, hematite, limonite				0.7				
741		Pigment source			Ocher, hematite, limonite				0.3				
441		Pigment source			Unidentified metamorphic				0.1				

APPENDIX J: 41HM51 JAYROE SITE FAUNAL ANALYSIS

41HM51 JAYROE SITE FAUNAL ANALYSIS

Jodi A. Jacobson, Susan Sincerbox, and Taylor Bowden

CENTER FOR ARCHAEOLOGICAL STUDIES

Texas State University-San Marcos

February 2019

FAUNAL ANALYSIS TEAM

Detailed analysis of all faunal material recovered by the site was subcontracted to the Center for Archaeological Studies (CAS), Texas State University by AmaTerra. The Senior Faunal Analyst/Principal for the project was Dr. Jodi A. Jacobson, Associate Director of CAS, who has over 26 years of experience in cultural resources management, 23 of those years conducting work as a faunal analyst. Dr. Jacobson received both her M.A. and Ph.D. in Anthropology with a concentration in Zooarchaeology from the University of Tennessee. Her Master's research focused on determining new methods for interpreting skeletal part frequencies of white-tailed deer through the development of white-tailed deer utility indices, including understanding the potential for marrow and bone grease within deer remains and contrasting that with other ungulate species such as bison. Her dissertation work focused on identifying biometric and morphological means for differentiating between mule deer and white-tailed deer post-cranial skeletal remains and used the results to re-analyze faunal material from a Central Plains site, the Scott County Pueblo Site in southwest Kansas. She has conducted research on the expansion of the Prairie Peninsula including reanalysis of deer remains from Rodgers Shelter and Brynjulfson Cave, resulting in re-evaluation of the environmental understanding of the site. She has conducted contract faunal analysis on 23 archaeological sites from all over the United States including the Southeast, Northern Plains, Central High Plains, and Texas. Dr. Jacobson directed and oversaw all stages of faunal analysis work while working on those parts of the project as well. She directed what data was to be analyzed, conducted initial sorts of the majority of the data, compiled background research on all areas not specifically called out below and guided research in the additional areas as well, and led or provided interpretations on the current project. She was assisted by both her co-authors and two additional individuals. Dr. Jacobson also conducted a pre-project zooarchaeological osteological identification short course for all assistants on her project.

Susan Sincerbox, received her M.A. degree in Biological Anthropology with a concentration in Forensic Anthropology from Texas State University formally in August 2018 but had completed all coursework prior to commencement on the current project. Ms. Sincerbox is the primary author on a published article concerning Forensic Taphonomy and Ecology of North American Scavengers, has conducted in-depth research on taphonomic signatures and ecological variables which effect the scavenging behavior of vertebrates, and has significant osteological experience working on both archaeological and forensic burial exhumation for 4 separate projects, as well as acting as a volunteer labelling and curating skeletal elements of donated specimens to the Forensic Anthropology Center at Texas State (FACTS). As an undergraduate she processed bone collected from 19th century site in Castroville, Texas and also explored microbial preservation in evaporate minerals which formed in soda lake environments. Ms. Sincerbox helped with base identifications of faunal material under the guidance and tutorial of both Dr. Jacobson and Dr. Chris Jurgens, as well as some detailed research and investigations on taphonomic factors, scavenging, and alluvial actions as well as general data processing, analysis, and compilation.

Taylor Bowden is a current 3rd year graduate student pursuing her M.A. at Texas State University in Anthropology with a concentration in Archaeology. In addition to completing coursework in Vertebrate Physiology, Human Osteology, Methods in Skeletal Biology, Paleopathology, Texas Archaeology, and Statistics in Anthropology she has participated in both Archaeological field schools and Forensic field methods courses. She has conducted work processing human skeletal remains and conducting experimental archaeology digging an underground earth oven and preparing food in the oven to determine what and how archaeological remains would present in the record. She also served as Graduate Assistant on recent field excavations in the Caribbean with both historic archaeological material and a historic cemetery excavation. Ms. Bowden helped with base identifications of faunal material under the guidance and tutorial of Dr. Jacobson and Dr. Jurgens, as well as conducting some detailed research on cultural modification of bone (butchery, tool, and thermal alteration) and optimal times for grease consumption and degrees of edibility/rancidity, in addition to general data processing, analysis, and compilation.

Dr. Chris Jurgens is a CAS staff member and received his M.A. in Anthropology from Texas Tech University and his Ph.D. from the University of Texas, Austin. His Master's thesis focused on a model for food resource availability and use within Choke Canyon Reservoir in south Texas while his dissertation included a detailed analysis of the faunal material from Arenosa Shelter (41VV99) in the Lower Pecos region of Texas. Dr. Jurgens most recently conducted all analysis on the faunal material from the Spring Lake data recovery project in San Marcos. He also taught an undergraduate Zooarchaeology class at Texas State University this summer and has over 44 years of experience as a professional archaeologist. While Dr. Jacobson spent the majority of her time overseeing the project and directly overseeing all identifications, Dr. Jurgens aided Ms. Sincerbox and Ms. Bowden with identification questions if Dr. Jacobson was unavailable. He also served as an internal reviewer of the faunal analysis sections of the report.

Megan Mall is an undergraduate in Anthropology at Texas State University. Ms. Mall has volunteered at FACTS and participated in both archaeological and forensic field projects. Ms. Mall assisted in early phases of the project with some initial general sorts of some bone, data sheet corrections, and helping correlate available cultural data with provenience and inputting such in data sheets.

INTRODUCTION

Background

Testing and data recovery excavations of 41HM51 were undertaken by Prewitt and Associates under the auspices of the Texas Department of Transportation (TxDOT). Zooarcheological studies conducted during the data recovery phase were designed to determine species variability, human subsistence strategies, taphonomic processes, and cultural use of bone. Research design questions related to fauna are presented in detail in Chapter 3, but are also summarized briefly in this chapter. All preliminary and feasibility studies conducted on the faunal remains recovered from the site are summarized and presented herein, though some were initially submitted to TxDOT as stand-alone reports (Quigg 2014, Dockall 2016, Jacobson 2018). Also presented here is a current and complete detailed analysis of all faunal remains recovered from 41HM51 during both testing and data recovery. All data are presented as a site overview and then individually by strata allowing for intra-site comparison within a temporal framework. Vertebrate remains recovered during ¼-inch screening of excavated deposits and heavy fraction flotation by Prewitt and Associates were analyzed and results are presented.

The primary issues that were to be addressed with current studies include:

- Define how sites where bones were processed for marrow extraction would differ from those where both marrow and bone grease extraction were conducted would present archaeologically in Texas.
- Document to what extent bones at 41HM51 were processed for bone marrow and bone grease.
- Compare skeletal element presence with potential for bone grease yields and how that may vary based on season of death as determined through analysis of age profiles or other associated animal seasonal characteristics.

- Determine conclusively whether the comminuted bone recovered from the site was due to bone grease extraction by human occupants of the site or due to taphonomic processes such as prolonged exposure prior to burial, trampling, etc.
- Evaluate non-ungulate species such as canids, raccoons, and rabbits that have historically demonstrated potential for grease extraction to determine if processing of bone grease, if present, was limited to ungulate only species or other animals as well.
- Evaluate previously conducted feasibilities and studies and determine their accuracy based on the current data and information.

The above items are discussed in the following sections. In addition, the current analysis revealed other significant cultural information previously undocumented at the site which is also presented.0

INITIAL INVESTIGATIONS OF FAUNAL MATERIAL

Introduction

Analysis of the faunal material was conducted in stages with an initial small budget feasibility study of fauna conducted by Quigg (2014), an additional review of his data by Prewitt and Associates (Dockall 2016), and the development of additional research avenues by Jacobson (2017). These studies are presented in this section. A more formal analysis of the complete assemblage is presented in following sections.

Feasibility Analysis

Quigg 2014

The initial small-budget feasibility analysis for Prewitt and Associates was conducted by J. Michael Quigg in 2014. As part of this analysis, Quigg measured and identified each specimen to the lowest possible taxonomic level and to element and portion when possible, as well as recording the presence or absence of burning, rodent gnawing, and cultural modifications.

Quigg found the assemblage to be highly diverse, with identified specimens including bison (Bison bison), deer (Odocoileus sp.) and pronghorn (Antilocapra americana), canids (Canis sp.), raccoon (Procyon lotor), rabbits and hares (Leporidae) and rodents (Rodentia) as well as a variety of birds (Aves), bony fish (Osteichthyes), turtles (Testudines) and snakes (Serpentes). A large proportion of the assemblage was found to be very small in size (< 3 centimeters [cm]) and lacking diagnostic characteristics, and consequentially many specimens could not be identified to element or taxon. Evidence of modification by both cultural activity (e.g., burning, cut marks, percussion impacts) and taphonomic agents (e.g., staining by manganese oxide, rodent gnawing, rounding by digestion or water transport) was present in the assemblage.

Quigg interpreted the site as representative of campsite activity due to the taxonomic diversity of the assemblage and evidence of intensive bone processing. Based on the faunal assemblage, Quigg hypothesized the following about subsistence practices at the site:

The location of most cut marks on bison and deer size elements are characteristic of stripping meat from the bone, with the size of the cuts indicating that a sharp flake tool was used.

The elements present at the site suggest that only nutritionally valuable portions of bison were transported to the site, while carcasses of deer-size prey were transported whole.

Quigg suggested long bones of larger animals were initially broken to extract marrow, with the bone sometimes weakened by burning before being struck with a hammerstone. Bone was then further fragmented and boiled to manufacture bone grease, resulting in the high frequency of small and unidentifiable fragments at the site. Based on the presence of fetal bison fragments, Quigg projected a spring season of occupation. In addition to large game, Quigg found evidence of rabbit, bony fish, bird, and turtle utilization, but interpreted bones of rodents and snake as being intrusive. Although Quigg briefly mentioned the presence of bones from canids, he did not discuss them further.

Quigg had limited time and a limited budget to complete his analysis of the assemblage, which he acknowledges in his report. Due to the limited time, much of the heavy fraction bone was left unidentified. Due to limited time and budget along with a limited number of comparative specimens, many of his identifications of the ¼-inch mesh-retrieved bone were frequently not as detailed or taken to as specific a taxonomic level as possible. Quigg noted that he was very rushed to get through basic taxonomic identifications. Data on the assemblage's taphonomic history was consequently sparse, largely limited to general observations of staining, rodent gnawing, and abrasion.

Bone Grease. Fresh Fracture Index, and Taphonomy

Dockall 2016

The faunal assemblage recovered from 41HM51 was reassessed in 2016 by Dockall to test the assumption that the high degree of fragmentation at the site was due to cultural activity, specifically marrow extraction and bone grease rendering. This study included a review of Quigg's original data and a reanalysis of a sample of the assemblage using Outram's (1998, 2002) Fracture Freshness Index (FFI) and size grading method.

Dockall noted the faunal assemblage includes bones with clear spiral fractures, indicating intentional breakage for marrow extraction, but also includes significant amounts of weathering and dry breaks. Dockall found that of the taphonomic modifications noted in Quigg's original data, 77 percent of observations were of intentional cultural modification while 23 percent could be attributed to noncultural agents, including rodents and weathering. Evidence of water transport was minimal, with rounding observed on only seven bones, and no evidence of carnivore scavenging was reported. His interpretation was that these results indicate that some of the fragmentation observed in the assemblage could be taphonomic, rather than intentional breakage for bone grease processing. To assess the roles of cultural and noncultural agents in producing the assemblage, Dockall completed a size grade analysis on a sample of 1,240 specimens (16 percent of the assemblage by number) from 18 excavation units of the Toyah component. The sample weighed 3,090.7 grams (g), representing 21 percent of the assemblage by weight. Specimens were assigned to size grades in 10-millimeter (mm) increments between 20 and 100 mm, with complete elements and unbroken epiphyses considered as a separate category. The total mass of each size grade was recorded and 57 percent of the sample (1,940.0 g) fell into the largest size class and complete element categories. Dockall interpreted this as an excess of large fragments and unbroken elements/epiphyses, and uncharacteristic of assemblages produced from bone grease processing.

Dockall also completed an FFI analysis on the sample described above. The FFI is a sum of scores for three fracture characteristics (outline, angle, and surface texture) used to assess whether a fracture occurred in green or dry bone. Ultimately, each fragment is assigned an index score between 0 and 6, with scores of 0-2 representing fresh breaks, scores 3-5 representing breaks that occurred during drying, and a score of 6 representing breaks that occurred when the bone was completely dry (Outram 2002). Dockall found that approximately two-thirds of the bones in the total sample had a score of 6, indicating that most breakage was taphonomic. However, when including only fragments that were likely to be exploited for bone grease processing (primarily long bone diaphyses, epiphyses, and unidentifiable fragments), 48 percent of the subsample had FFI scores consistent with fresh breaks, indicating that a significant proportion of long bones were processed further after butchering.

FFI data Dockall collected for bones from artiodactyls indicate that fresh breaks were more common in deer/pronghorn than in bison, which suggests that smaller artiodactyls were processed differently than bison. Dockall argues that the bones of deer and antelope were broken primarily for marrow extraction and not processed for bone grease, evidenced by the survival of grease-laden long bone epiphyses and compact elements (i.e., carpals, tarsals, and phalanges). Bison bones were also broken for marrow, but less frequently. Dockall suggests this may be due to the large size and thickness of bison bones, which could make marrow extraction from bison bones more difficult. Alternatively, the differences may occur because the taxa were utilized by separate occupations that differed in terms of seasonality, duration, or time constraints. Based on the abundance of complete compact elements and long bone epiphyses, Dockall concludes that most breakage of artiodactyl long bones was intended to extract marrow rather than to fragment bone for grease manufacture.

It should be noted that because Dockall drew from Quigg's original analysis, the taphonomic observations reported in the 2016 report differ considerably from the observations made during the current study. While Dockall reports minimal evidence of water transport, the current study identified macroscopic abrasion characteristics in a large proportion of the assemblage. Nearly 10 percent of specimens examined for abrasion had abrasion characteristics without evidence supporting an alternative process (e.g., carnivore digestion or tool use). Dockall also noted an absence of carnivore modification from the assemblage. In contrast, we found that nearly a fifth of the assemblage presented with evidence of carnivore modification such as the presence of pits, punctures, or scores. Dockall's size grade analysis was completed on a relatively small sample of the total assemblage. The current study did not weight individual specimens, so cannot directly address the distribution of mass by size class across the entire assemblage. However, Dockall's claim that the assemblage contains an excess of large bones remains to be seen. Of the large (>9 cm) specimens observed during the current study, more than half were reconstructed from conjoining fragments, and over 10 percent of those had at least one spiral fracture indicative of an intentional break.

Dockall used only the FFI to differentiate between bone fractured by taphonomic processes and cultural ones. Our analysis, in contrast, was able to segregate bone with evidence of various taphonomic impacts (alluvial, carnivore gnawing, rodent modification) to ascertain what degree of breakage was associated with those activities in order to demonstrate that the high number of very small fragments could not be fully explained by taphonomic factors. Dockall, however, had to rely on the data available in Quigg's (2014) database which was not readily searchable or missing the information needed to gather this information for comparison. Finally, the FFI was designed to identify marrow extraction and the criteria it relies on cannot be used to assess comminuted fractures created during grease rendering. Although FFI can support the presence of bone processing, it is not a reliable measure to confirm bone grease extraction specifically on its own, as the developer of the method has himself indicated (Outram 2002).

REANALYSIS, DATA NEEDS, AND RESEARCH QUESTIONS

Jacobson 2018

In 2017, TxDOT contracted Dr. Jodi A. Jacobson to reassess the initial investigations of the faunal assemblage at 41HM51 to determine the assemblage's potential to generate additional knowledge regarding processing of bone at the site and to weigh in on the differing conclusions regarding bone grease and marrow processing at the site presented by Quigg (2014) and Dockall (2016). A report was submitted to TxDOT in January 2018 documenting her findings.

Jacobson acknowledged the assessment of site seasonality as important for understanding bone processing behavior at the site due to seasonal fluctuations in the storage of fat in animal bones, which may influence decisions regarding whether to process bone further for grease. Additionally, the utility of bone grease as a food resource differs seasonally due to high summer temperature, which would promote spoiling and reduce the time that rendered bone grease could be stored before turning rancid and inedible. Evidence supporting site seasonality is limited to fetal bison bone fragments in previous reports, although a review of the original Quigg data indicates that additional evidence for season of death is available including unfused long bones and vertebral caps, mandibles and maxillae with dentition, antlers, and a fish otolith.

Jacobson also promoted the consideration of species-specific utility indices and skeletal part frequencies when assessing bone fragmentation patterns. Elements with higher utility would be more likely to be fragmented, whether for marrow extraction or rendering of bone grease, and thus skeletal part frequencies need to be considered in the context of their utility. Jacobson also argued that taxa besides artiodactyls need to be analyzed, as some smaller species (e.g., raccoons, rabbits, and waterfowl) have high grease indices and may also be utilized for bone grease manufacture.

In contrast to Dockall, Jacobson argued against using an FFI analysis to assess breakage in the 41HM51 assemblage because of the relationship between bone grease and fracture type. Fresh or "green" fractures differ from dry fractures due to differences in bone elasticity and resilience, which is afforded to bone by its organic components – the grease. As grease is removed from a bone, the bone becomes more and more likely to break in a "dry" manner. During bone grease manufacture, bones are fragmented and boiled to remove the grease. Consequently, bone that has been processed for bone grease would be more likely to incur post-depositional, "dry" breakage that could obscure original intentional breaks, artificially increasing the bone's FFI score. Instead, Jacobson recommends a simpler analysis of identifying dry versus fresh (green and spiral) breaks along with a comparison of other data such as degree of weathering, frequency of burning, and overall fragment size.

Overall, Jacobson recommended a full reanalysis of the faunal assemblage within the context of the entire site. Bone grease production may vary over time due to seasonality of occupation or changes in resource availability, dietary stress, or activity patterns of site inhabitants.

CURRENT RESEARCH AND THE BONE GREASE VERSUS BONE MARROW PROCESSING QUESTION

Within the last 20 years there have been numerous studies examining bone breakage at archaeological sites. These studies have focused on utility of the various elements of prey species to determine their function as both meat bearing and marrow or grease bearing bones (Jacobson 2000, Madrigal (2004), Emerson (1990), Binford (1978), Will (1985), Borrero (1990), etc. Decisions regarding the reasons behind processing the bone for marrow or bone grease, including as an additional boon for seasonal storage or out of need during times of dietary stress, have been discussed and applied to various archaeological sites (Baker 2009; Logan 1998; Watson and Thomas 2013; Karr et al. 2014; Outram 1999; Rush 2013; Klippel and Systellion 2013). Studies examining the question of bone grease and marrow have also examined ethnographic information and how that may be applied to the archaeological assemblage (Vehik 1977.). Additional related studies have looked at differentiating between intentional human breakage, dry bone taphonomic breakage, and fresh carnivore breakage (Blumenschine 1986; Haynes 1981, 1982; Klippel et al. 1987). A brief summary of that information relevant to the region around 41HM51 and potential animals utilized at the site is presented below along with additional climate data that is relevant when considering functionality for when bone grease would have been utilized.

Utility

Beyond just gross size comparisons of fragments, not all bones are equal for the degree of bone grease or marrow that can be retrieved. Any discussion of potential breakage with regard to bone grease or marrow use should be undertaken with consideration of existing species-specific utility indices. Prior analysis of the site did not pull in information from previous studies identifying which elements have been shown to have higher marrow or bone grease utility. For the most prevalent species at the site—bison and deer—Emerson (1990), Jacobson (2000), and Madrigal (2004) have conducted detailed studies, analyzed the utility (meat, marrow, and bone grease composition) of individual bones, compared the utility across element, and discussed how that may vary seasonally. Animals catabolize fat deposits from the long bones at different rates depending on species, so utility indices need to be assessed independently to each species. In addition, knowledge of how fat reserves in the bones may vary seasonally for each species could affect skeletal part frequencies and bone fragmentation rates. The elements with highest utility would be those most likely to be fragmented for both marrow and bone grease.

Fat Catabolization

It is well documented that the degree of fat present in bone marrow cavities is directly correlated to how much fat deposits are present on the kidney in deer (Jacobson 2000). For instance, femur fat will not start to be depleted until the Kidney Fat Index drops below 30 percent. This means that any hunter would have knowledge on the viability of breaking open a bone for marrow and grease processing prior to doing so based on observations during initial butchering activities of the animal at the kill site. Decisions whether to haul certain bone elements, versus easily stripping off available meat from long bones to transport and discarding heavy bone, would be made at the time of initial gutting of the animal.

A comparison of the frequencies of identifiable elements to known utility of those elements would provide better data for determining if bones were being transported to the site because of their potential for marrow or bone grease. For instance, while brain matter, cheek meat, and tongues provide some nutrition, skulls are heavy and are generally found in less frequency at habitation sites than at kill sites. They take labor to transport and provide little return. The tongue, the largest meat item, can be easily removed without transporting the skull, though brains may be retained for hide processing. Mandibles are more difficult to open than long bones and provide less in marrow and bone grease return than long bones. But metacarpals and metatarsals which are low on meat utility scales in contrast to vertebrae or upper limb bones, typically have moderate utility for marrow and bone grease. Furthermore, based on the way deer catabolize their fat stores, the femur, humerus, tibia, and radius marrow fat is mobilized at similar rates with the upper limbs just above the lower, but the metapodials are the last holdout for fat storage and will maintain high fat levels even when the femur has dropped below 30 percent. There would be reasons to transport metapodials to a habitation site despite being heavy dense bone, but only if marrow and/or grease extraction were an intended goal. In addition, if a kill occurred close to a habitation site where easy transport of the whole carcass was possible, it could be anticipated that metapodials would be broken for marrow and bone grease even if the animal's body fat was depleted. In a similar state, human energy may not be expended fracturing a humerus or femur if body fat reserves were mostly depleted. Any discussion of whether marrow and/or bone grease were a primary goal of subsistence should include analysis of skeletal part frequencies.

Fat Types and Use in Marrow and Bone Grease

Bone marrow and bone grease extraction are important subsistence strategies used by Plains peoples. Bone marrow is found within bone cavities may vary in consistency from gelatinous to denser solid fat. The marrow cavities of the appendicular skeleton in mammals are initially used during infancy and early youth for production of blood cells and is primarily "red marrow." As the animal ages, the medullary cavities of the long bones switch from blood cell production to fat storage, or "yellow marrow." Yellow is formed as fat infiltrates and degenerates the cells. Within spongy bone cavities of both the long bones and pelvis, ribs, etc., the primary marrow is red with minimal to no fat deposition. Therefore, the primary fat component exists within the medullary cavities of long bones and would be expected to increase once primary growth is complete (Getty 1975). Red marrow is found in bones closest to the body's core where there is a higher degree of trabecular cavities and it typically has a higher melting point (Emerson 1990). Yellow marrow in the long bones, though, is full of fat and easily extractable. Bones can be broken and due to its more solid nature, the fat easily removed from the marrow cavity. No tool more than something to strip flesh away from the bone and a heavy implement like a rock to smash open the cavity is needed to access marrow.

Bone grease is more difficult to attain as it occurs within the bone structure itself. Bone grease also has two different types, yellow and white. Yellow grease has been called the "better kind" because it does not harden (Logan 2017). However, it is the white grease that is more often utilized by hunter-gatherers due to its lower melting point. Oleic acid is the fatty acid in bone grease that has the lowest melting point. Grease containing more oleic acid melts at lower temperatures, and though yellow grease does not harden, white grease contains more oleic acid and melts at a lower temperature (Logan 2017). White grease is most often found in the extremities while yellow grease is most often found in elements of the axial skeleton. The preferred bones to render white grease from are the articular ends of long bones because they are rich in oleic acid (Morin 2007).

Rendering fat takes a long time at low heat. This is because the fat is not meant to be cooked, rather just heated enough to melt it. Lard begins to melt anywhere from 97 to 107 degrees Fahrenheit (36–41 °C) and is ready for putting up at 255 degrees Fahrenheit (124 °C). It is important that the fat is cooked slowly and stirred often. Ideally, it should be stored in as cool of an environment as possible because bacteria begin to multiply rapidly at temperatures over 40 degrees Fahrenheit (4 °C). Bone grease is extracted by boiling the bones in water and waiting for the grease to rise to the top. Water boils at a minimum of 212 degrees Fahrenheit (100 °C), and experimental studies conducted by Rush (2013) found that the bones must boil for a number of hours before grease is rendered. Rendering and skimming took the better part of a day, though extraction seemed to maximize from the bones under a 2-hour time expense mark per sample in the work done by Rush (2013). It would be possible to focus on the best grease-producing bones to maximize return and minimize involvement.

Experimental and Ethnographic

Experimental and ethnographic studies have been carried out to determine how bone grease was rendered. Outram (1998) and Binford (1978) and others have noted in general that boiling bone in heated water is the best. Rush (2013) conducted experimental archaeology on bone breakage and marrow and grease extraction on bison bone as part of her thesis research. Boiling pits were prepared and bones were fractured using limestone and granite cobble hammers. Limb elements had been frozen, so bone was not fully defrosted, nor were they fully defleshed when broken so some of the results are not indicative of actual conditions (stripped of meat and fresh not frozen bone). Rocks were heated in a fire and placed in the pot until heat had been transferred, then removed as other heated rocks were added to keep the water boiling. Regardless, findings found that cold collection of the fat (skimming once boiling had ceased and water cooled) was easiest. Collection while boiling required additional heating to evaporate out remaining water to get to just solitary fat (Rush 2013). This stage would not be necessary if fat was consumed in a rich broth instead.

Ethnographically, studies in the Plains suggest two primary ways of boiling bone for extraction. For those like the Crow and Mandan, who sought to primarily render specifically for the bone grease with liquid either discarded or consumed as a byproduct, the fat would be scooped off the surface as it was being rendered (Vehik 1977). Some groups dug pits, lined with clay, and lined with hide then filled with water. Rocks were heated nearby and dropped into the water along with bone fragments until the water was heated. Other methods involved heating in pots both through direct heat and the addition of heated rocks until boiling. Bone was crushed, though to what degree they needed to be crushed varied based on the reason for rendering and the group conducting the processing. As bones were depleted of their grease they were ladled out and disposed of, potentially within the fire or mixed with the ash remains upon completion of the activity. In a lined pit it could be assumed some small fragments would slip back into the feature during cleanup.

Vehik (1977) mentions some groups on the Plains, like the Chukchee, were not interested in primary production of bone grease as a stand-alone resource, but instead would use a similar method to create "soup" by which the bone grease is boiled out as a stock into the liquid of the pot. While some may be skimmed off for other function, the primary purpose would to be to consume the bone grease as part of the soup. In this method, the bone fragments would likely be ladled out of the pot with the assumption many would make their way as trash into the fire. This method has been documented amongst other hunter-gatherer groups as welland would work best if utilizing the bone grease for immediate consumption rather than long term storage. In addition, Vehik's (1977) detailed summary of various Plains ethnographic studies suggest that all bone would have been used such as pelvis, sacrum, ribs, vertebrae, etc., but that the best quality grease came from the long bones. That supposition is in keeping with Emerson's (1990) findings on bison utility.

In addition to nutritional purposes, animal fat can also be used as a softening agent during hide processing. Summarizing ethnographic accounts, Schultz (1992) provides a general overview of the processing of bison hides in Plains populations. After skinning, the hide is generally stretched and soaked in a solution to promote the removal of tissues and hair. Fats, tissues, and membranes are then removed and the hide is thinned. During "braining," a mixture of cooked animal brains is rubbed into the hide to soften it (Schultz 1992). The brain mixture is then removed, the hide is wrung and stretched again, and "grained" to smooth remaining rough patches. Finally, the hide may be smoked to impart it with color and prevent stiffening. Wiederhold (2004) reviews hide processing in depth and discusses variation. While brains are the predominant component of the softening agent, other animal fats such as bone grease may be incorporated into the mixture, which is often cooked and applied warm (Wiederhold 2004). Warming the softening agent promotes penetration into the dermal fiber layer of the hide, where hydrophobic chemicals replace water that binds collagen fibers in the skin during life (Leighton 1994). Replacing the water molecules forestalls rotting, prevents stiffening as the hide dries, and imparts some water resistance (Leighton 1994, Wiederhold 2004).

Bone Breakage

Studies have shown that low density bone (Lyman 1994) and highly weathered bone (Behrensmeyer 1978) are more likely to break post-depositionally. The portion of the appendicular skeleton most likely to be culturally broken for marrow manufacturing is the denser long bone shaft, but the portions most likely to be broken for bone grease extraction are the less dense long bone epiphyseal sections (Baker 2009). In addition, Behrehnsmeyer's (1978) weathering index partly relies on the amount of moisture versus desiccation in a bone with a scale of 0–5. The lowest degree of weathering, stage 0, is actually partly characterized by the bone being still "greasy" and stage 2 is characterized by the stage at which marrow has decayed and cracks are forming in the bone. Therefore, the degree of weathering and amount of bone breakage is directly correlated with amount of bone grease in the bone. Boiling a bone would remove the ingredient responsible for bone resilience, the bone grease, leaving the bone at a higher probability for post-depositional breakage. From a taphonomic standpoint, anyone who has processed a recently deceased animal to produce a comparative skeletal specimen can tell you that low heat cooking on a stove of a fleshed specimen will result in a better specimen with longer term preservation than boiling at high heat of defleshed bone. The grease in the bone is essential to its ability to survive taphonomic processes.

In addition, most researchers have assumed that bone fragments must be small (<3 cm) in order to maximize extraction of grease from bone while boiling (Church and Lyman 2003). Research by Church and Lyman (2013) found that large sections (diaphysis segment and epiphysis segments) took five hours in order to extract 80 percent of the grease whereas smaller sections could extract the same level of bone grease in only 2–3 hours. Statistically the speed at which bone grease is rendered increases as size of bone fragment decreases; however, the lots of 4 cm, 2 cm, and 1 cm-sized fragments were not as significantly different from each other as any was from the large diaphysis and epiphysis segments according to the experimental study. After just one hour of boiling the 1 cm size fragments had rendered 63 percent of their total grease, the 2 cm size fragments had rendered 56 percent of their total grease and the 4 cm size fragments had rendered 41 percent of their total grease. During times of drought and/or in the open areas of Texas fuel for heating fires could be sparse. The amount of fuel necessary to keep a fire hot enough to heat stones to boil water and the number of stones that must be heated and added to the fire may make the added labor of additional fragmentation more feasible than sustaining a fire and continually reheating stone for more than three hours. It could be anticipated that, from a labor standpoint, some fragmentation beyond that needed for marrow extraction would be necessary to reduce the timeframe for grease extraction during boiling to less than six hours. However, the decision on just how small bone is fragmented could be partially dependent on the amount of fuel and quantity of rock necessary for boiling and associated labor and resource trade-offs. In the end, it may be more efficient to spend the extra time reducing the bone to minimize the time spent boiling for extraction. Boiling for bone grease in lithic or wood resource-poor areas would need to be as short a timeframe as possible, suggesting more intensive fragmentation of bone for bone grease extraction in these areas than as may occur in others.

Climate Considerations

Outram (1998:21) states that there are two main reasons bone grease processing may not occur, one of which is "if the climate (or season) is too warm to allow for the satisfactory storage of bone in non-rancid condition then it is unlikely sufficient material could be massed at one time to warrant large scale production of grease." In addition, while for processing the "melting" point of bone grease is relevant for extraction from bones, it could affect the long-term storage of fat in warm climates. According to Outram (1998) most combinations of fats extracted from bone have melting points between 20 °C and 70 °C (68 °F and 158 °F). Obviously, the melting points could affect the stability of pemmican in warmer seasons of Texas as current median temperatures in Texas during Spring/Summer range from 66 °F in April up to 86 °F in June with record Summer high recorded as 111 °F (NOAA 2017). Given the warmer nature of Texas's Spring and Summer season, marrow or rendered bone grease would have a short timeframe of viability before starting to go bad. This does not mean that these resources would not be utilized, they just may have been consumed in a more immediate fashion with the meat alone dried for later consumption, or produced during more predictable late fall and winter cooler seasons with the animal fats where storage could accommodate for a longer use timeframe. In warmer seasons when bone grease is prone to rapid spoilage, one might speculate that the grease could instead be used for a non-nutritional purpose such as hide processing. No known anthropological research has yet examined how the use of rancid fat may impact hide products. However, rancid animal fat may also reintroduce bacteria or fungi to the hide, promoting rot and the unpleasant odors and textures that accompany it. Furthermore, animal fat breaks down into chemical byproducts such as aldehydes and methyl-ketones, which are more soluble in water than the fat itself (Lea 1939). Consequently, these chemical changes may reduce the effectiveness of rancid fat as a softening agent. There may have been practical as well as aesthetic reasons to avoid the use of rancid fat during hide processing. Modern day discussions related to leather industry has noted that rancidity of the fats or oils can damage leather and its use should be avoided (GlenKaren 2018).

Therefore, drawing on analogies from the Northern Plains may not be as relevant for sites in Texas. The Mitchell Site in North Dakota, a village site with evidence of year-round occupation (Karr et al. 2015) was initially contrasted with 41HM51 in Dockall's (2016) analysis. However, mean temperatures in North Dakota, and therefore viability of longer storage of fat/grease via pemmican, would differ from Texas. The rendering of fats for marrow and grease extraction is important for preservation. Dry rendering of fats in a cool and dark environment allows for prolonged storage. In contrast, fats rendered in warm and wet environments are likely to go rancid quicker. This is especially important when considering Texas climate. Texas is relatively warm all year round and typically is not cold enough to keep fat from going rancid for longer than a couple of weeks. This means that resources would need to be extracted sooner rather than later (Rush

2013). Most ethnographic studies indicate that the majority of Plains and northern Prairie bone grease processing and pemmican production were conducted in the Fall and Winter (Baker 2009). Therefore, a site focused on bone grease processing may vary in representation in warmer months, when fat survives for shorter times and animals have less fat stored, than in the advance to Winter when fat deposits on animals would be at their highest and the resource could be stored as a viable food resource for a longer period. Furthermore, bone grease and bone marrow processing would be expected to be of less need in the Spring and Summer when resource availability, including both plant (including fats from nuts) and other animal resources, should be at its highest. Processing for these labor-intensive fat resources during Spring/Summer could be an indicator of stress or limited resource availability. However, in early Spring human fat reserves would also be depleted and any source of fat, even if minimally provided in a soup, may have been sought. Drought is common in Texas, and if resources were low, a heavier degree of processing may be worth the meager returns.

While additional research is presented, one of the primary debates with the previous two studies was whether bone fragmentation was due to intentional breakage of the bone for marrow, grease, by other taphonomic factors, or a mixture of the above. For the current research, the authors have hypothesized methods for identifying whether bone was processed for marrow or bone grease with the consideration of smaller scale and multi-seasonal processing under consideration. Furthermore, they have outlined methods to differentiate heavy fragmentation due to human versus various taphonomic factors.

Identifying Processing for Marrow Extraction or Bone Grease Manufacture in Texas

Processing animal bones to access fat stores and grease leaves distinct traces in the archaeological record. In order to extract bone marrow, bone must be broken in order to access medullary cavities. For the manufacture of bone grease, bones would be crushed into small fragments and boiled to extract and render stored fat.

Evidence for Marrow-Only Processing

Extracting bone marrow requires breaking open long bones to extract marrow while it is still edible. Consequently, breaks produced during marrow extraction are characteristic of fresh or green bone breaks, with smooth fracture surfaces and evidence of plastic bone deformation. Spiral fractures are a strong indication that a break occurred while the bone was fresh. Breaks produced by marrow extraction will generally occur in the diaphysis, leaving the epiphyses intact, and may be evidenced by the presence of percussion impacts. In addition, as yellow marrow exists only within medullary cavities, the elements that will contain this resource are limited to long bones of the appendicular skeleton and the mandible. Intentional bone breakage of only these elements at a site would be an indicator that marrow extraction was occurring. In a faunal assemblage, a site or feature used exclusively for marrow processing may be represented by:

- High proportion of larger fragments.
- High proportion of fragments with intact epiphyses, allowing classification to taxonomic class.
- High proportions of fresh fractures, including spiral fractures.
- Presence of recognizable percussion impacts.
- Green and Spiral breaks on primarily marrow containing bones of long bones and mandible.

Evidence for Bone Grease Manufacture

Not all bones store sufficient fat to make processing for bone grease extraction worthwhile. Bone grease extraction may only occur in a subset of faunal remains recovered from a site, preferentially seen in bones from greasier taxa or skeletal elements. Bone grease extraction is also more efficient if bone is broken into smaller fragments after marrow is removed. These fragments are then boiled, allowing stored fats to leach out of the trabecular bone. Heating and removing the organic components of bone leaves it more brittle, and thus more susceptible to post-processing fragmentation and weathering. Bone may also be burned during bone grease extraction if used bone is added, intentionally or accidentally, to the fire after removal from the heating area. In the archaeological record, evidence of bone grease manufacture includes:

- Bones of larger taxa represented by high proportion of small (<3 cm) fragments.
- Fragments show higher degree of weathering relative to other bones on site.
- Different patterns of breaks in bones of different taxa or types of long bones that correspond to available fat reserves.
- Presence of burned bone fragments.
- May have presence of intentional breakage (spiral breaks) of greater range of skeletal elements, not just those with a medullary cavity.

It is likely that both processes could occur onsite and both may be present. Some bones may have been broken for marrow, yet not further reduced for bone grease due to depletion of those reserves already. Any analysis should look at comparisons within site between species with regards to intact nature of bone, weathering, frequency of spiral fractures, percussion impacts and overall size of fragments, as well as examining variations within a species when good contextual control is possible. Unfortunately, as stratigraphy suggested, fluvial disturbance and temporal context were not as reliable; some discussion of the relationship of these variables is limited.

Differentiating Human Processing from Taphonomic

The analysis by Quigg (2014) referenced both carnivore modification and alluvial abrasion of the bone. It is important to consider the influence each may have on the identifiers above and provide consideration for both. Human modification for bone grease production should favor reduction of artiodactyls, with potential use of other greasy species such as rabbits, racoons, canids, and waterfowl such as geese and ducks. Therefore, comparisons of skeletal part frequencies, fragmentation degree, percussion impacts, intentional human breakage or spiral fractures, and degree of weathering would be more likely to occur on these species that could be used as a control for taphonomic indicators which would be less discriminating across all taxa.

IDENTIFICATION AND ANALYSIS

Background

All of the bone assessed during the feasibility study by Quigg (2014) was re-analyzed. All bones analyzed were identified through use of the analyst's private faunal collection, use of loan specimens from the University of Tennessee's Department of Anthropology's Vertebrate Comparative Skeletal Collection, a visit to the University of Texas's Vertebrate Paleontology Lab, and assorted identification manuals and articles (Olsen 1964, Olsen 1968, Olsen 1979, Cohen and Serjeantson 1996, Jones and Manning 1992, Romer 1997, Balkwill and Cumbaa 1992, Jacobson 2004, Ford 1990). Taxonomic classification follows Schmidly (1994) and Davis and Schmidly (2018) for mammals, Stebbins (2003) for reptiles and amphibians, Peterson (1988) for birds, and Page and Burr (1991) for fish. All identification and analysis was conducted by or under the direct supervision of Dr. Jodi Jacobson. All bone was identified to the most specific taxonomic level possible. When diagnostic characteristics were not as variable, for example presence of a character which had been noted as defining only 65 percent of the time in bison, identifications to species were listed as "compares favorably" or "c.f." For example, in the case above a species determination would have been listed as c.f. Bison bison.

As not all of the animal bone was identifiable beyond class, size categories were used to differentiate the various bones for analytical purposes. Size categories by class or other taxonomic level are useful for understanding human subsistence strategies and prey choice preference (high biomass versus low biomass) within an environment. Size categories may also give an indication of an environment's overall species richness (Lawton 1990). The size categories for mammals included large (e.g. bison, cattle, horse), medium-large (e.g. deer, antelope, pig), medium (e.g. dog, raccoon, bobcat), small-medium (e.g. opossum, beaver, skunk), small (e.g. rabbit, prairie dog, squirrel), very small mammal (e.g. wood rat, hispid cotton rat, vole), and microtine mammal (e.g. mouse, shrew). Size categories for birds included large (e.g. swan, bald eagle, great blue heron), medium-large (e.g. goose, turkey), medium (e.g. mallard duck, caracara, red-tailed hawk), and small (e.g. dove, American golden plover, screech owl). Size categories for reptiles included very small (e.g. gecko, earth snake), small (e.g. racers, nonvenomous snakes), and medium (e.g. rat snakes). Additionally, turtle was prevalent enough that broader classification of medium testudines (e.g. river cooter, slider, box turtle) and small testudines (e.g. mud turtle, immature box turtle) were utilized when identification beyond order was not possible. Identified Artiodactyla bones not identifiable to species were subdivided into large artiodactyl (e.g. bison, cow, elk), medium-large artiodactyl (e.g. white-tailed deer, mule deer, pronghorn antelope) and medium or larger artiodactyl (any artiodactyl such as bison or deer of a size larger than a sheep or goat). Enough specimens were classifiable to the family Muridae (rats, mice, and voles), but not to species that subcategories of very small muridae (e.g. cotton rats, wood rats, prairie vole) and microtine muridae (e.g. plains harvest mouse, Texas mouse, northern pygmy mouse) were included.

In addition to taxonomic and elemental identifications, data including portion of element present; degree of fusion; age or sex of animal indicators; cultural modifications to the bone (cuts, chops, percussion impacts, tool modification or use); any thermal alteration evidence and degree of burning; evidence of animal modification such as rodent or carnivore gnawing or breakage; taphonomic modifications from root etching, alluvial abrasion, and degree of weathering; types of bone fragmentation such as spiral or dry breaks; and any pathologies (e.g. healed breaks, arthritic lipping, pitting and reabsorption of bone) were all recorded during analysis. This kind of detailed analysis and interpretation of it requires significant training and therefore all recordation and checks of all analyses were either conducted by Dr. Jodi Jacobson or under the direct supervision of Dr. Jacobson by graduate students and recent Master degree-level technical staff with extensive past osteological experience. Summaries of material recovered from the site as a whole and discussions regarding environment and subsistence strategies, taphonomy, cultural bone modifications, and interpretations are discussed in the following sections, along with a discussion of the same topics divided by strata.

Differences from Quigg (2014) Analysis

As with any analysis carried out by different researchers there was some variation in the analyses. In addition, resources, including time and budget, were different between the initial and current analyses, which allowed for more in depth identifications in most cases. Some overall differences affecting data robusticity are presented here.

A total of 76 fragments initially identified and quantified by Quigg (2014) as bone were reassessed and determined to be non-bone, primarily rock/lithic or botanical but including some invertebrate shell. Anyone who has ever conducted detailed artifact analysis would be aware that while conducting quick sorting on the marco level it is often difficult to differentiate denser botanical material or "bone colored" lithic material from bone. Time allowed more detailed analysis with the current review and microscopic analysis combined with tactile examination was used to differentiate the 76 fragments as a material other than bone.

In addition, while it is possible some additional breakage of bones may have occurred in between analyses, there is still some discrepancy in total bone counts. Some of that is attributable to bone breakage that may have occurred with the most fragile bone sections between the initial Quigg (2014) analysis and the current evaluation, but in other cases may be differences in assumption of whether fragments conjoined (making the number of identified specimens [NISP] = 1 instead of 2) or not (resulting in an NISP = 2 instead of 1) that could effect and result in different overall bone counts. Overall though, it was determined after accounting for bone removed for analytical dating that only one fragment identifiable beyond class and to element was missing from the comparative specimens analyzed by the authors of this chapter—the proximal radius from a mature female bison. For number totals, that missing element along with the radiocarbon (C14) bone samples previously removed, the analytical information is defaulted to that provided by Quigg (2014) as independent analysis was not possible.

Quigg reported a total of 7649 bone fragments, though 76 of those were determined to not be bone. Current analyses include 7651 fragments of bone, 29 fragments of invertebrate shell (including Gastropoda and Coleoptera), and 47 fragments of rock or botanicals. Overall, approximately one percent of the material received was not bone.

Of the bone Quigg (2014) analyzed, only 35 percent could be assigned beyond indeterminate vertebrate to Class, yet the current study was able to assign approximately 57 percent (n=4392) of the faunal material to Class or more specific taxa. Specifically, roughly 28 percent could be assigned to class, 13 percent to order, eight percent to taxonomic family, seven percent to genus, and a bit over one percent narrowed to two or fewer possible species.

Table J-1 presents a summary of the taxonomic comparison of the current taxonomic classifications to Quigg's original classifications. The ways in which Quigg's classifications compared to the current study were broken down into four categories. Identifications could be matched or identified to the same taxa at the same taxonomic level (e.g., both of us identified only to family level of "Canidae"). Identifications could be different, such as Quigg identifying as bone an artifact that in the current study was identified as non-bone, or a bone fragment that was identified to the same taxonomic level but not the same taxa (e.g., Quigg identified as "Sciruidae" but we identified as "Leporidae"), or a bone fragment identified to a different taxonomic level and in a different taxa (e.g. Quigg identified as "Rodentia" but we identified as "Aves"). Alternatively, Quigg's identifications were in some cases more specific or to a lower taxonomic level than we were comfortable assigning due to overlap with other closely related species. In other cases Quigg's identifications were less specific or to a higher taxonomic level than the classifications assigned in the current study as where we had greater confidence in a more specific taxa designation (e.g., Quigg assigned as "deer" (Odocoileus sp.) where we could assign to mule deer "Odocoileus hemionus").

Table J-1. Comparison of Quigg's Original Taxonomic Classifications to Current Study.

Quigg's Identification Compared to Current Study	NISP	Proportion
Match	3797	49.63%
Different	159	2.08%
More Specific	1104	14.43%
Less Specific	2667	34.86%

In terms of taxonomic classifications, Quigg's identifications matched the current study for roughly half of the faunal material analyzed, and the current study was able to assign about 35 percent of specimens to a lower taxonomic level. This study could not agree on classifications at the same level as Quigg in just under 15 percent of specimens, but could confirm that they belonged to the same group at a higher taxonomic level. Stark differences between the original and current taxonomic classifications were observed in two percent of specimens, including those that were identified as material other than bone. Many of these differences occurred in specimens from small animals.

Table J-2. Comparison of Quigg Element Identification to Current Study.

Quigg's Identification Compared to Current Study	NISP	Proportion
Match	4538	58.73%
Difference	1957	25.33%
More Specific	1027	13.29%
Less Specific	205	2.65%

This study also analyzed Quigg's identification of skeletal elements, using the same four categories as above to compare his identifications to the identifications made in the current study. This data is summarized in Table J-2. Almost 60 percent of the original identifications effectively matched skeletal elements identified in the current study, while differences (including non-bone) were observed in about 25 percent. Many of these differences appear to occur due to rapid analysis and assumptions that fragments would refit with an identified element, with others resulting from the small size of elements. The remaining skeletal identifications were either more specific (e.g., identifying turtle shell fragments as carapace when it could not be distinguished between carapace and plastron) or less specific (e.g., identifying as a metapodial when it could be further specified to metatarsal) than those of the current study.

In summary, our taxonomic classifications matched the original classifications made by Quigg in roughly half of the specimens, and our element identifications matched approximately 60 percent of the time. In terms of taxonomy, Quigg's classifications were frequently left broader than ours. For skeletal elements, Quigg's identifications were more frequently more specific or completely different from current identifications.

Site Overview

The total vertebrate number of identified specimens (NISP) recovered from the site was 7653of which 4365 (57.0 percent) were identifiable to class, though an additional 713 bones (9.3 percent of the assemblage) could be narrowed to one of two classes (mammal/aves or amphibian/osteichthyes for example). Those specimens are included in the "Vertebrate" section in Table J-3 below, but identified as an either/or class in the faunal inventory. Table J-3 below follows the updated online version of The Mammals of Texas (Davis and Schmidly 2018) for taxonomic designations and ordering of mammals, rather than the earlier (Schmidly 1994) edition. The dominant class of vertebrate represented in the assemblages was mammal accounting for 86.2 percent (n=3764) of the bones identifiable to class. Fish, with 309 bones (7.1 percent) identifiable to class, accounted for the second most prevalent class of remains present. The high ability to identify to fish was mostly due to the highly identifiable characteristics of catfish bone fragments, which dominated the fish assemblage. Reptiles, with 166 bones (3.8 percent.) identifiable to class, accounted for the third most prevalent class of remains present, followed closely by birds with 122 bones (2.8 percent). There were also 7 amphibian bones (0.2 percent) and 3 non-determinable herptile bones (<0.1 percent) identified from the assemblage. A detailed account of taxa identified and the NISP and minimum number of individuals (MNI) for each taxa are listed in Table J-3.

Rarely are over 50 percent of the bones from a Texas assemblage identifiable to class. It is even more unique that over 57 percent of the assemblage could be identified to class given the diversity of the assemblage and because over 83 percent (n=6,379) of the assemblage consisted of fragments that were 3 cm in size or less. The distribution of bone by class is presented in Figure J-1.

For comparison, Wilson-Leonard is considered one of the more well-preserved archeological faunal assemblages in Texas and is located in a similar open (non-rockshelter) alluvial setting in Williamson County (Baker 1998). Of the total 15,309 vertebrate remains recovered from ¼ inch screens at Wilson-Leonard, only 30 percent were identifiable to class or more specific taxon. Of the total 38,618 specimens recovered from the ⅛-inch screens, only 32 percent were identifiable to class or more specific taxon. At Wilson Leonard only 0.7 percent of the ¼-inch screened and 0.6 percent of the ⅛-inch screened bone was complete and unbroken.

Table J-3. Vertebrate Remains Recovered from 41HM51 Data Recovery.

Class	Taxa (Common Name)	NISP	MNI
Mammal	*Didelphis virginianus* (Virginia opossum)	2	1
	Sylvilagus audubonii/floridanus (desert/eastern cottontail rabbit)	2	1
	Sylvilagus sp. (cottontail rabbit)	6	2
	c.f. *Sylvilagus* sp. (cottontail rabbit)	4	
	Lepus californicus (black-tailed jackrabbit)	6	1
	Lepus sp. (jackrabbit)	5	1
	c.f. Lepus sp. (jackrabbit)	7	
	Leporidae (rabbit/hare)	24	
	c.f. Leporidae (rabbit/hare)	8	
	c.f. *Tamia* sp. (chipmunk)	1	1
	Spermophilus c.f. *mexicanus/tridecemlineatus* (Mexican/thirteen-lined ground squirrel)	3	2
	Sciurus c.f. *niger* (eastern fox squirrel)	1	1
	Sciurus sp. (fox/gray squirrel)	2	1
	Sciuridae (squirrel/prairie dog)	1	
	c.f. Sciuridae	3	
	Geomys busarius (plains pocket gopher)	1	1
	Geomys sp. (pocket gopher)	4	2
	Geomyidae (pocket gopher)	4	
	c.f. Geomyidae	1	1
	C.f. *Dipodomys* sp. (kangaroo rat)	1	1
	Peromyscus sp. (mouse)	1	1
	Sigmodon hispidus (hispid cotton rat)	4	2
	Sigmodon sp. (cotton rat)	9	3
	c.f. Sigmodon sp. (cotton rat)	4	1
	Microtus sp. (vole)	1	1
	Muridae (rats/mice/voles)	27	
	c.f. Muridae	1	
	Small Rodent	1	
	Very small Rodent	6	
	Small c.f. Rodent	1	
	Canis sp. (dog/coyote)	8	1
	c.f. *Canis* sp. (dog/coyote)	1	
	Canidae (dog/coyote/fox)	4	1
	Procyon lotor (northern raccoon)	7	1
	Mephitis mephitis (striped skunk)	1	1
	Medium Carnivore	2	
	Odooileus virginianus (white-tailed deer)	20	2
	Odocoileus hemionus (mule deer)	5	1
	Odocoileus sp. (deer)	416	4
	c.f. *Odocoileus* sp. (deer)	7	
	Large Cervidae (elk/deer)	1	
	Odocoileus/Antilocapra (deer/pronghorn)	213	

Class	Taxa (Common Name)	NISP	MNI
Mammal	*Antilocapra americana* (pronghorn antelope)	4	1
	Bison bison (bison)	22	2
	c.f. *Bison bison* (bison)	10	
	Bovidae (bison/cow)	294	
	c.f. Bovidae (bison/cow)	3	
	Large Artiodactyla (bison/elk)	25	
	Medium-large Artiodactyla (deer/pronghorn/sheep)	138	
	Medium or Larger Artiodactyl	493	
	c.f. Artiodactyla (medium-large)	4	
	c.f. Artiodactyl (large)	1	
	Large Mammal	9	
	Medium-large Mammal	98	
	Medium Mammal	36	
	Medium or larger Mammal	1317	
	Small-Medium Mammal	19	
	Small Mammal	4	
	Very small Mammal	1	
	Miscellaneous Mammal	287	
	Subtotal	**3764**	
Aves	c.f. Ardeidae (heron)	1	1
	Ciconiformes (Ibis/Spoonbills)	1	1
	Olor columbianus (whistling swan)	2	1
	Medium Anatidae (geese/ducks)	1	1
	Buteo jamacensis (red-tailed hawk)	1	1
	Buteo sp. (buzzard hawk)	1	
	Accipitriformes (hawk/eagle)	1	1
	Accipitripiformes/Strigiformes (birds of prey)	1	1
	Grus sp. (sandhill/whooping crane)	1	1
	Scolopacidae. (willet/woodcock/plover)	1	1
	Cyanocitta/Aphelocoma (jay)	2	
	Small Passeriformes (perching bird)	1	1
	Very Small Passeriformes (perching bird)	1	1
	Large Aves	8	
	Medium-large Aves	7	
	Medium Aves	25	
	Medium or larger Aves	9	
	Small-Medium Aves	36	
	Small Aves	15	
	Very Small Aves	6	
	Miscellaneous Aves	1	
	Subtotal	**122**	

Class	Taxa (Common Name)	NISP	MNI
Reptile	*Terrapene* c.f. *ornata* (western/ornate box turtle)	2	1
	Terrapene sp. (box turtle)	8	1
	c.f. *Terrapene* sp. (box turtle)	16	1
	Graptemys versa/kohni (Texas/Mississippi map turtle)	2	1
	Graptemys sp. (map turtle)	2	1
	c.f. *Graptemys* sp. (map turtle)	10	1
	Pseudemys texana/concinna (Texas/eastern river slider)	2	1
	Pseudemys sp. (river cooter)	1	1
	Trachemys/Pseudomys (slider/cooter turtle)	1	1
	Emydidae (pond turtle)	11	
	Gopherus c.f. *berlandieri* (Texas tortoise)	1	1
	Medium Testudines (turtle)	24	
	Small Testudines (turtle)	50	
	Testudines (turtle)	10	
	c.f. *Sceloporus* sp. (spiny lizard)	1	1
	Coluber constrictor (racer snake)	1	1
	Elaphe sp. (rat snake)	2	1
	Elaphe/Bogertophis (rat snake)	2	1
	Medium Colubridae (non-venomous snake)	2	
	Small Colubridae (non-venomous snake)	2	
	Very small Colubridae (non-venomous snake)	1	
	Serpentes (snake)	8	
	Miscellaneous Reptile	2	
	Subtotal	**166**	
Amphibian	c.f. Caudata (salamander)	4	1
	Bufo sp. (toad)	2	1
	Miscellaneous Amphibian	1	
	Subtotal	**7**	
Herpetiles	Reptile/Amphibian	3	
Osteichtheyes	*Ictalurus* sp. (channel catfish)	1	1
	c.f. *Ameirus* sp. (bullhead catfish)	1	1
	c.f. *Pylodictis* sp. (flathead catfish)	2	1
	Pylodictis / Ameiurus (bullhead / flathead catfish)	1	1
	Ictaluridae (catfish)	201	3
	Aplodinotus grunniens (freshwater drum)	1	1
	Large Osteichtheyes	2	
	Medium-large Osteichtheyes	37	
	Medium Osteichtheyes	14	
	Small-medium Osteichtheyes	13	
	Small Osteichtheyes	10	
	Very small Osteichtheyes	14	
	Miscellaneous Osteichthyes	18	
	Subtotal	**309**	
Vertebrate	**Miscellaneous Vertebrate**	**3288**	
TOTAL		**7653**	

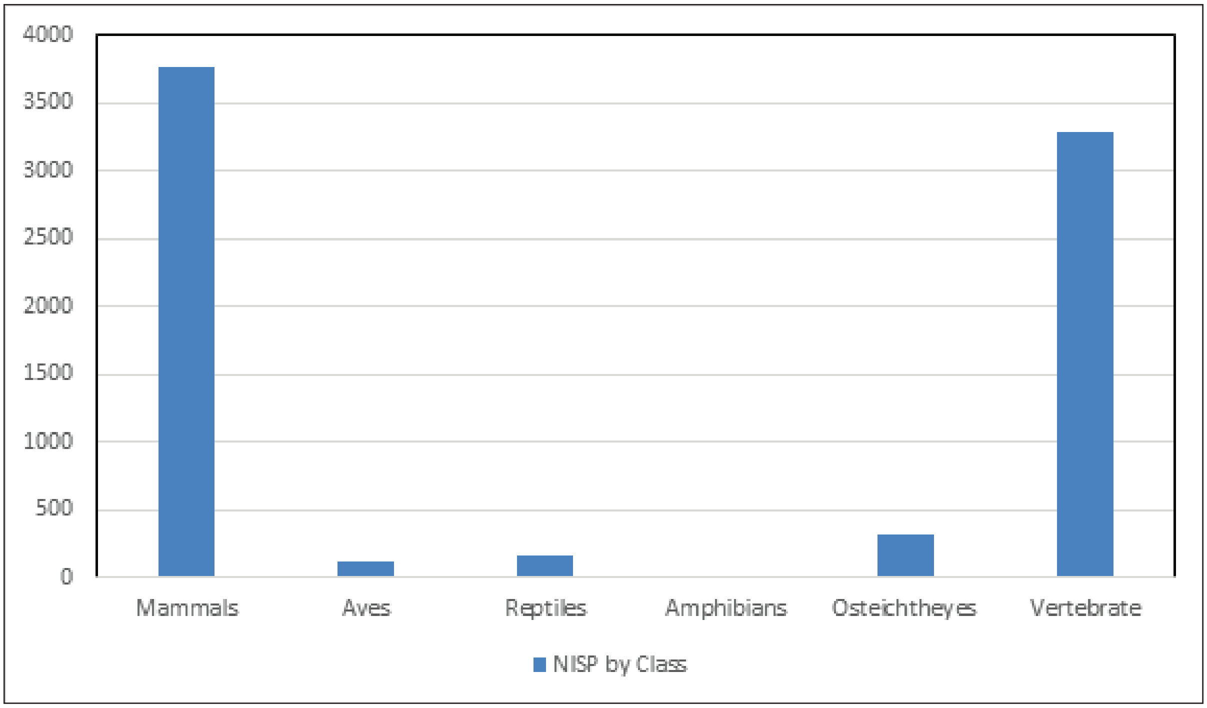

Figure J-2. Distribution by Class of bone recovered during 41HM51 Data Recovery.

The Siren Site (41WM1126) is a Late Archaic and Late Prehistoric site also located in Williamson County. The Siren Site has a large faunal assemblage that was analyzed in detail by Klippel and Synstelien (2013). There has been solid interpretation of some of the assemblage from the Siren Site being associated with bone grease extraction and it is regionally and temporally relevant as a comparative model to the Jayroe Site (41HM51). Some levels at the Siren Site have a high degree of fragmentation, and yet over 73 percent of the assemblage could be identified to Class. Approximately 20 percent of the large artiodactyl and 68 percent of the medium artiodactyl recovered at the Siren Site were 3 cm or less in size. Just over one percent of the total bones from the site were whole unbroken elements. In contrast the faunal assemblage from the Jayroe Stie 41HM51 was even more heavily fragmented than the Siren Site. In fact, over 28 percent (n=2146) of the assemblage was less than 1 cm in size (Table J-4).

Table J-4. Size Breakdown of Bone Recovered from the Jayroe Site (41HM51).

TOTAL NISP	<1 cm	1-3 cm	3-6 cm	6-9 cm	9-12 cm	>12 cm
7653	2146	4233	938	192	52	91

Despite the heavy fragmentation, the bone was highly identifiable and a plethora of bone was recovered. The faunal assemblage data are highly informative with regards to environment, subsistence strategies, butchering and processing, cultural bone modification, evidence for presence of domesticated dog, and taphonomic conditions.

Species Frequencies by Class

Mammal

There were a total of 3,764 mammal bones recovered from 41HM51. Overall, large mammals (e.g. bison, cow, large bovid, and large artiodactyl) accounted for 363 bones (9.6 percent of the mammal assemblage). Medium-large mammals (e.g. deer, pronghorn antelope, medium-large artiodactyls) accounted for 905 bones (24.0 percent) of the mammal assemblage. Medium mammals (e.g. dog, coyote, raccoon, medium carnivore) only accounted for 59 bones (1.6 percent of the mammal assemblage), but a general grouping of medium or larger mammals accounted for 1810 bones (48.1 percent of mammal assemblage). All told, all mammals included above of medium-size or larger accounted for 3137 bones, or 83.3 percent of the total mammal assemblage. Small-medium (opossum) and small mammals (e.g. cottontail rabbit, squirrel) accounted for 93 bones (2.5 percent of the mammal assemblage). Very small mammals and microtines (e.g. cotton rats, wood rats, mice, voles) made up 1.9 percent (n=70) of the assemblage. For a detailed species list refer to Table J-1.

Given the groupings above, subsistence would have been primarily focused on medium or larger mammals. Small mammals were not widely selected. While the very small mammals and within the assemblage could be predominantly intrusive or naturally occurring, there is evidence for human subsistence due to cultural modification on some of the very small mammals. Coprolite studies from the Lower Pecos indicate that cotton rats, voles, and other rodents were commonly consumed by Native Americans (Bryant 1974; Reinhard and Bryant 1992; Texas Beyond History 2013). For that reason, all mammal species present at the site are considered as potential subsistence resources.

Analysis revealed a couple of taxa that were present that occur outside of their current range. One chipmunk (c.f. *Tamia* sp.) nearly complete mandible was identified from the assemblage. The mandible was identified by using both manuals (Jones and Manning 1992; Lowery 1974; Nagorsen 2002) and through comparison to a wide array of ground squirrels, rats, other similar sized rodents, and chipmunks at the University of Texas Vertebrate Paleontology lab. It did not match with ground squirrel but its characteristics were a complete match only for chipmunk. Identification was left at the compares favorably (c.f.) level of certainty due to its occurrence outside of known range and similarity between chipmunk species. *Tamias canipes* (gray-footed chipmunk) are forest dwelling chipmunks with a modern range in Texas limited to higher elevations of the Sierra Diablo and Guadalupe Mountains in the Trans-Pecos Region (Schmidly 1994). They are an isolated population suggesting that at one point their range must have extended further to end up in a remote location. *Tamia striatus* (eastern chipmunk), which prefers deciduous forests, has a modern westernmost distribution as the northeastern border of Texas along the Red River (Burt and Grossenheider 1980). *Tamia striatus* has, however, been recorded at a late glacial (10,000–15,000 years B.P.) site in Central Texas named Cave Without a Name in Kendall County (Faunmap 1994). Therefore, the range did extend much further at one time and its presence is possible. It is also possible the mandible was transported to the site as part of a pelt from a further distance and was not naturally occurring in the area.

There is one recorded "large cervid" in the material identified. There was a cervid deciduous premolar within range of the size of a modern Elk (*Cervus elaphus*). The tooth was compared to numerous bison, cow, larger pronghorn and both white-tailed and mule deer. All characteristics were in keeping with a deciduous premolar, yet given the nature of it being deciduous, it was larger than any of the mule deer and white-tailed deer specimens on hand and a solid match for a younger elk in the University of Texas Vertebrate Paleontology Lab collection. Again, because it occurred outside its modern range, and researchers allowed for the potential of a much larger than average mule deer, identification was left as the closest shared taxonomic grouping (large Cervid). Elk typically inhabit plains in the winter and inhabit open, forested areas in the summer. There were Elk historically present within Texas that were extirpated by 1900 A.D. They were native to the Guadalupe Mountains in western Texas (Scmiddly 1994). As both the chipmunk and large cervid present that were identified beyond their modern ranges had an overlapping historical range in the Guadalupe Mountains, Culberson County, Texas, their presence may indicate travel to or trade with that region.

An analysis of minimum number of individuals (MNI) indicates similar reliance as NISP. For the most part, only one bone, or no more of any one element was present for most species. In those cases, the MNI was determined to be 1. The mammal species with the greatest MNI was tied between deer and cotton rats. *Odocoileus* sp. MNI was determined based on 4 left maxillary second molars including three maxilla segments and one loose tooth. The fragments were of varying age, so the number cannot be increased due to juvenile presence as the elements fall within all age ranges represented at the site. In addition, white-tailed deer (*Odocoileus virginianus*) had an MNI of 2 based on two right distal tibia epiphyses. While it is possible the white-tailed deer tibias overlap with at least one of the maxillary fragments from the generalized deer, the two tibia are indicative of the same age range and would only overlap with one of the maxilla, allowing for at least an overall combined MNI of 6 for deer when mule deer MNI is included. Hispid cotton rat (*Sigmodon hispidus*) has an MNI of 2 based on two overlapping right mandible segments. In addition, there were three right mandible segments for non-specific cotton rat (*Sigmodon* sp.) and one 1 right mandible compares favorably (c.f. *Sigmodon* sp.) that also overlap the hispid cotton rat segments allowing for a total overall MNI for cotton rats equal to 6. Bison MNI was 2 based on two right complete ulnar carpals. Pocket gopher, ground squirrel, and cottontail each had an MNI of 2 based on two left maxillary incisors, two left mandibles section with incisor, and two right mandibular sections with 2nd and 3rd molars, respectively.

Aves

There were a total of 122 avian bones recovered from 41HM51. Large aves (e.g. whistling swan, crane, heron) accounted for 12 bones (9.5 percent of avian assemblage). Medium and medium-large aves (e.g. duck, hawk, Ibis) accounted for 38 bones (31.4 percent of avian assemblage) recovered. Small aves (e.g. willet/plover, jay) accounted for 19 bones with an additional small-medium intermediate sized aves accounting for 36 bones, combined a total of 45.1 percent of avian assemblage). There was also a minor presence of very small aves (e.g. finch, bluebird) in the assemblage (n=7, 5.7 percent of avian). The MNI for each bird present in the assemblage was one.

Reptile

There were a total of 166 reptile bones recovered from 41HM51. Medium-sized reptiles, specifically turtle but some snake as well, dominated the reptile assemblage accounting for 85 bones or 51.2 percent of the reptiles recovered from the site. There were no large reptiles (e.g. alligators) recovered from the site. Small reptiles (e.g. mud/musk turtles, small snakes) accounted for 53 bones (31.9 percent of the reptile assemblage). Very small reptiles (very small snakes and lizards) made up only 1.2 percent (n=2) of the reptile assemblage. Similar to mammals, while some researchers may assume that only the medium-sized reptiles were consumed, there is coprolitic evidence from southwest Texas and elsewhere (Bryant 1974, Reinhard and Bryant 1992) that Native Americans consumed small lizards as well as rodents. Given other evidence for cultural modification of the bone (cuts and thermal alteration), all reptile species are considered potential subsistence resources. The majority of turtle bone present were carapace and plastron segments that could not be used to determine MNI.

Amphibian Remains

There were only seven amphibian bones recovered from the site. Species present included two toads the size of medium and large woodhouse toad, and four salamander bones. There were also three bones classified as herptile that was indeterminate between reptile and amphibian. Similar to the arguments with rodents and reptiles, the amphibians present are considered potential subsistence resources. MNI for all amphibian taxa were one.

Osteichthyes

There was a total of 309 bony fish remains recovered from 41HM51. There was one freshwater drum otolith, easily recognizable to species, and a high percentage of catfish which are structurally easier to identify then most fish. There were 21 large fish fragments, mostly catfish, accounting for 6.8 percent of the assemblage. Medium-large fish accounted for 81 bones (26.2 percent), medium fish accounted for 67 bones (21.7 percent) and fish of a medium size or larger accounted for 22 bones (7.1 percent), meaning the fish assemblage was dominated (61.8 percent) by older fish of medium size or larger (n=191). Very small (n=18), small (n=11) and small to medium (n=21) fish accounted for 5.8 percent, 3.6 percent, and 6.8 percent of the fish assemblage respectively. Due to the identifiability of catfish, there were an MNI of at least 3 based on three right caudal articular sections. Fish can drastically vary in size within their lifetime. Channel catfish (*Ictalurus punctatus*) can range from four inches long to up to 50 inches. For this reason, a channel catfish could be classified anywhere from a small to a large fish. Species associations with general size classifications are not possible for fish. Fish size, however, has been directly correlated to intensity of fishing. Intensive angle fishing of channel catfish on the Platte River in Nebraska was noted to lead to a decrease in fish size as the fish were being harvested prior to reaching peak size. Population numbers would actually increase, but size decrease, as more small fish took over ranges previously inhabited by larger ones (Blank 2012).

There was direct cultural evidence for the use of most species present at the site, including rodent and lizards, to suggest the majority of fauna present was utilized as a subsistence resource. It is possible that some of the bone present was intrusive (rodents) or naturally occurring, but overall evidence supports all species present were intentionally utilized by human occupants.

Environment

The species present indicate that a wide range of habitats were utilized by the human occupants of 41HM51. Opossum, gray squirrel, fox squirrel, chipmunk, white-tailed deer, the jay (*Cyanocitta/ Aphelocoma* sp.) and other perching birds are indicative of forest or forest-edge environments (Schmidly 1994). While raccoons can inhabit many habitats, they require a nearby wooded riparian habitat as well. While not possible to determine what species of *Peromyscus* mouse is present from the morphological characteristics, most require woodland edge, scrub brush, or rocky outcrops for cover. Mule deer, cottontail rabbits, black-tailed jackrabbits, and Texas tortoise prefer shrub brush/chaparral habitats (Schmidly 1994), though black-tailed jackrabbit and the Texas tortoise prefer dry scrub. Kangaroo rats and the hispid cotton rat will generally use more open sparse scrub habitat, though kangaroo rats prefer dryer scrub in keeping with the black-tailed jackrabbit. In addition, the ground squirrels present could inhabit scrub brush to open grassland environments. Bison, pronghorn antelope, pocket gopher, and ornate box turtle are also indicative of open prairie and grassland. There was one crane (*Grus* sp.) bone indistinguishable to species. Sandhill cranes are known to winter in the high plains in Texas preferring prairie environment with nearby shallow water source, while whooping cranes are migratory stopping over at wetlands on their migratory journey to the coast.

Species abundance strongly supports use of a wetland or aquatic habitat due to high NISP for species associated with these habitats. In addition to the cranes, numerous water fowl, wading, and wetland-based avian species were identified at the site, including heron, ibis or spoonbill, whistling swan, and members of the Anatidae family consistent in size with goose or duck. Additional aquatic species included box turtles, slider and river cooter turtles, map turtles, other indeterminate pond turtles, salamander, and the numerous fish including channel catfish, bullhead catfish, flathead catfish, indeterminate catfish, and freshwater drum (Schmidly 1994, Stebbins 2003, Peterson 1988, and Conant and Collins 1991).

Not all taxa presented could be definitively associated with specific habitats or ecotones. Some animals, like the *Microtus* voles, could provide more refined environmental data if species could be determined, as some species occupy only prairie and other only woodlands. However, morphological characteristics present would not allow designation to the species level. In addition, there are some species present at the sites which occupy too many different environments individually, (e.g. red-tailed and other buzzard hawks; toads) to be able to link a specific environment to their presence.

Overall, the species present are incredibly diverse and representative of multiple habitats. A breakdown of percent for each of the potential ecotones is presented in Figure J-2 below. Deer were the primary prey species utilized at the site and many bones could only be reduced to genus level deer identification and not further to mule deer or white-tailed deer species level. Mule deer and white-tailed deer occupy different habitats (scrub vs. riparian), therefore to account for their habitat presence the same ratio of known mule deer to white-tailed deer presence (1:4 based on NISP) was applied to bone only identified as "deer" and numbers included in the Figure J-1 chart. A fairly equitable distribution of ecotones were utilized with wetland/aquatic dominating the most by NISP and open/scrub representing the least by NISP. As Riparian habitats tend to be adjacent to waterways and are ranked second, species presence would strongly suggest that primary subsistence species were being attained close to the site from a wooded area along slower moving waterway with areas prone to ponding. There would be nearby open scrub habitat which could support some of the rodents and rabbits along with mule deer, but which was not in the direct daily-use vicinity of the site. It is worth noting that the prairie species present primarily consist of either larger prey such as bison and pronghorn, or easy to find prey such as ornate box turtles or pocket gophers who give away their location with above-ground mounding. There is a general absence of specific grassland rodents, such as harvest mice, that would be expected to naturally occur at a site if the surrounding area was grassland. However, there are some crossover species, such as the Hispid cotton rat, and others that possibly would represent grassland if a better species determination was possible. The lack of very small commensal or naturally occurring rodents would support a determination that, while being utilized, prairie environments would not have been within the immediate vicinity of the site. The discussion of skeletal part frequencies of bison in following sections also supports arguments for increased distance from kill site and selective part choice for transport of the faunal resources back to the site.

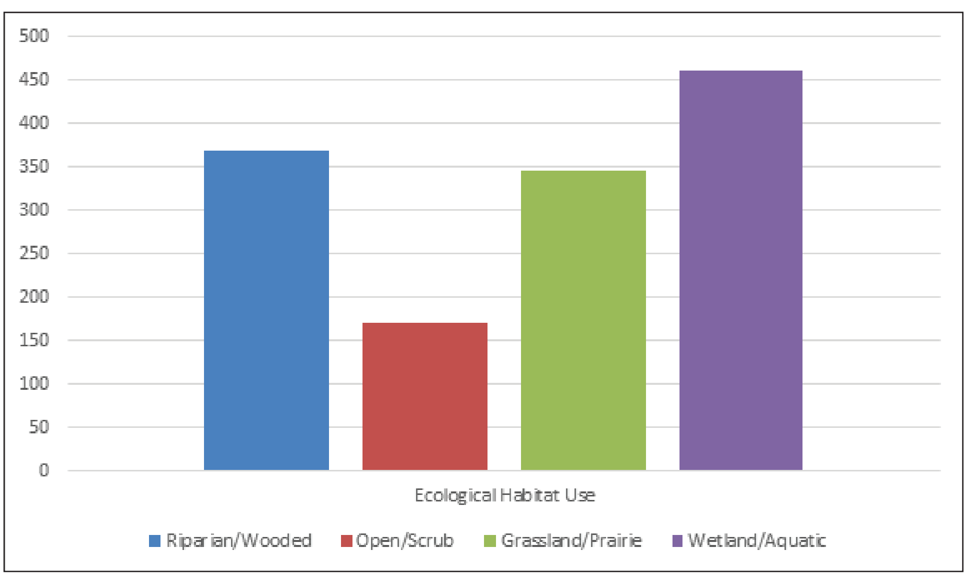

Figure J-3. Breakdown of bone NISP by species habitat use.

41HM51 Seasonality Evidence

There were several indicators for seasonal use of the site. Seasonality is based on the season of death of various animals and can be ascertained in many ways. Age profiles can be useful for determining season if younger animals which have a predictable season of birth are present. The season of death can be determined by projecting back to estimated birth dates (e.g. a 6-month old animal with standard parturition dates of May/June would indicate a death in November/December). Some animals also hibernate during cold seasons, or may have seasonal migrations. Their presence within an assemblage can indicate deaths during seasons where they would be an available resource based on these known patterns. Microscopically, some bone elements (fish otoliths, mussel shell, some teeth) have different seasonal growth patterns and can be examined for banding that would indicate the season of death.

The presence of cold-blooded reptiles (n=163, 2.1 percent of assemblage) indicate the site was used during warmer seasons. Many of the identified reptile specimens were turtle, which hibernate at temperatures below 38-45 degrees Fahrenheit (Roots 2006; NOAA 2013). Furthermore, as many amphibians and reptiles, especially land-based reptiles such as western box turtles, will estivate during times of drought, it is probable that the site was not occupied during mid-summer for the cultural component levels associated with drier species presence such as ornate box turtle.

Figure J-4. Deer antler with attached pedicle.

While antler was recovered from the site, antler is shed annually and was highly sought after as a resource for tool manufacture. Consequently, it does not necessarily indicate human subsistence and hunting. However, the condition of four antler specimens indicate that they were still attached to the cranium at the time of death. The pedicle of one of these specimens was still intact and attached to the parietal (Figure J-3). This specimen was no longer in velvet. The other three specimens were hardened, but still in velvet. Altogether, these antler specimens suggest an occupation of fall to early winter (October-December) based on the typical development of modern Texas deer (Schmidly 1994; Jacobson 1994; Marchinton and Miller 1994).

Additional indicators for seasonality were available due to the presence of young deer (Odocoileus sp.) and large artiodactyl bone. Given modern and historic reproductive cycles for white-tailed deer in the Hamilton County area (Jacobson 1994), the timing of parturition for white-tailed deer in this area is typically from May to early June. A deer first phalanx with an unfused proximal epiphysis indicates a fawn less than two months old, suggesting a Summer occupation between June and August. Though species of the immature bone was not able to be established and mule deer reproductive dates can differ slightly from white-tailed deer, in general, parturition of the two species is typically synchronic or only slightly offset in areas where the two species overlap (Whittaker and Lindzey 1999).

The large artiodactyl bone incudes a forming incisor or canine, a right femoral diaphysis, a left metacarpal, and two additional long bone diaphyses. As bison (*Bison bison*) are the only large artiodactyls definitively identified at this site, the analysis continues assuming all large artiodactyls are bison. Bison conception generally occurs between July and September, with calving occurring between April and June (Schmidly 1994; Haugen 1974; Borgreen 2010). The general size and characteristics of the young long bones are consistent with bison from newborn up to two months of age, consistent with a late Spring to Summer occupation (April-August) (Figure J-4). The development of the tooth is indicative of a bison between three and nine months of age, which is more consistent with a late Summer, Fall or Winter occupation.

Figure J-5. Femur of large bovid aged 0-2 months.

This site also yielded several migratory birds, the presence of which can inform season of occupation. The most compelling of the recovered elements include a tibio-tarsus and right humerus of a whistling swan (*Olor columbianus*), which is a winter inhabitant of the state. The tarso-metatarsus of a crane (*Grus* sp.) was also recovered, which could be either a whooping crane (*G. americana*) or sandhill crane (*G. canadensis*). While sandhill cranes can be found in different parts of Texas throughout the year, the whooping crane is a winter migrant and can be found between the plains and coast (October-April).

One freshwater drum otolith (ear stone) was also recovered from the site. Budget and available materials were not accounted for to include thin sectioning to determine age and seasonality of the drum. Otoliths are great indicators of season of death as they are formed from calcium carbonate deposition forming seasonal growth bands which appear opaque in summer and translucent in winter, are formed in layers, and exhibit growth bands (Simmons 1986). Given the existing evidence for year-round human occupation, it was determined the complex process and additional materials, cost, and supplies needed to analyze the drum otolith was unnecessary. However, the drum otolith is available should additional research avenues be warranted in the future.

Overall, most indicators suggest a fall to early winter occupation of the site. However, the presence of young deer and bovids along with cold blooded amphibians and reptiles also supports an occupation in late Spring and Summer. Therefore, the site was either occupied multiple times during multiple seasons or had a longer-term habitation consistent with year-round use. Initial research had hoped to focus on shifts in seasonality data across the temporal components to determine if there was a difference in elemental bone breakage choice due to their potential as marrow or bone grease resources. In Spring, for instance, when deer and bison fat reserves would be low, metapodials may have been more heavily fragmented for marrow. At that time upper limb bones may be less fragmented as bone grease and marrow reserves as a whole should have been mostly depleted. In late Fall and Winter by contrast, fat reserves in the long bones should be at their highest and all elements may have been processed for marrow and bone grease, or selection of only those yielding higher amount of fat content such as femur, humerus, and tibia targeted. Unfortunately, due to the geomorphological, radiocarbon, and cultural data available, finer detail beyond "Toyah" as an analytical occupation unit were not possible. Had it been, potential seasonal-specific components may have been possible to identify within the Toyah component. It was not, so it is not possible to address the affect seasonality may have had on bone breakage patterns as seasonality data is suggestive of all potential seasons of use. It should be noted that the youngest artiodactyls present (less than six months, neonate/fetal bones) exhibited only dry breaks and tended to have a lower degree of bone fragmentation than older more solidly developed bone. Animals in this age group would still consist of only "red marrow" and be in blood cell production mode rather than fat storage. The lack of intentional breakage of young bone can be reversed to infer that intentional breakage of older animal elements was in order to acquire a resource.

Cultural Bone Modification

The bone was examined for evidence of cultural modification, including cut, chop, other signs of processing such as a striking platform for bone breakage and marrow extraction, or any form of thermal alteration. Bone was also examined for modification into or use as a bone tool. Early on, a high degree of presence of percussion impacts was noted on the bone. Of the 7653 bones recovered from the site, 2006 (26 percent) had evidence for cultural modification (Table J-5).

Table J-5. Percent Culturally Modified within the Entire Assemblage (n=7653) by Class.

Class	NISP Modified	Percent of Bone in Entire Assemblage
Mammal	1235	16.14 %
Bird	41	0.54 %
Reptile	88	1.15 %
Fish	30	0.39 %
Vertebrate	422	5.51 %
Indeterminate	190	2.48 %
Total	**2006**	**26.21 %**

Table J-6 presents a further breakdown of cultural modification by specific taxon. Data in Table J-6 are not necessarily cumulative with respect to "Total NISP Modified." In some cases, only one bone had evidence for multiple types of modification. A bone exhibiting thermal alteration may have also had cut marks. While noted in both the "NISP Burned" and "NISP Cut" columns, the numbers were not added as they were representative of the same fragment (NISP = 1). As can be noted, in the table below the most frequent type of modification for mammals were cut marks and thermal alteration. There was a high degree of percussion impacts, however, especially with regards to artiodactyl bones. There was a minimal presence of percussion impacts to other species with abundantly greasy bones, such as cottontails and jackrabbits. The tool/other cultural column includes bones with abrasion consistent with human use wear and polishing, expedient bone tools whose fresh break sharp edge were utilized, bone bead templates, one potential bone whistle, and broken formal bone tools such as awls or awl points.

Table J-6. Cultural Modifications by Taxon.

Common Name	NISP Thermal Alteration	NISP Cut	NISP Chop	NISP Percussion	NISP Tool/ Other Cultural	Total NISP Modified
Dog/Coyote	1	2	1	0	0	4
Raccoon	1	2	1	0	1	5
Bison	5	17	3	3	2	30
Bison/Cow	18	98	8	26	19	169
Pronghorn Antelope	0	1	0	0	0	1
White-tailed Deer	1	6	0	1	2	10
Mule Deer	2	3	0	1	0	6
Deer	16	16	0	5	5	42
Pronghorn/Deer	35	60	1	40	13	149
Artiodactyl	102	84	0	36	27	249
Pocket Gopher	2	1	0	0	0	3
Cotton Rat	1	0	0	0	0	1
Rat/Mouse	2	0	0	0	0	2
Squirrel	3	1	0	0	0	4
Rodent	1	0	0	0	0	1

Common Name	NISP Thermal Alteration	NISP Cut	NISP Chop	NISP Percussion	NISP Tool/ Other Cultural	Total NISP Modified
Jackrabbit	1	3	0	2	0	6
Cottontail Rabbit	2	2	0	0	1	5
Rabbit/Hare	5	3	0	2	0	10
Opossum	2	0	0	0	0	2
Mammal	188	176	4	79	89	536
Subtotal	**388**	**475**	**18**	**195**	**159**	**1235**
Heron	1	1	0	0	0	2
Crane	0	1	0	0	0	1
Whistling Swan	0	1	0	0	0	1
Swan	0	1	0	0	0	1
Swans/Geese/Ducks	0	0	0	0	1	1
Water/Wading Birds	1	0	0	0	0	1
Red-Tailed Hawk	0	1	0	0	0	1
Jay	0	1	0	0	0	1
Willet/Woodcock/Plover	1	0	0	0	1	2
Bird	9	14	0	0	7	30
Subtotal	**12**	**20**	**0**	**0**	**9**	**41**
Texas/Mississippi Map Turtle	1	0	0	0	1	2
Texas Tortoise	1	0	0	0	0	1
Map Turtle	1	1	0	0	2	4
Box Turtle	15	3	0	0	7	25
Pond Turtle	1	0	0	0	2	3
River Cooter	1	0	0	0	2	3
Cooter/Slider	0	1	0	0	0	1
Turtle	26	0	0	1	14	41
Rat Snake	2	0	0	0	0	2
Snake	6	0	0	0	0	6
Subtotal	**54**	**5**	**0**	**1**	**28**	**88**
Bullhead/Flathead Catfish	0	0	1	1	0	2
Catfish	4	0	1	1	0	6
Bony Fish	13	5	1	0	2	21
Fish	1	0	0	0	0	1
Subtotal	**18**	**5**	**3**	**2**	**2**	**30**
Mammal/Bird	5	9	0	1	2	17
Mammal/Reptile	1	1	0	1	0	3
Reptile/Bony Fish	0	1	0	0	2	3
Herptile/Bony Fish	1	0	0	0	0	1
Subtotal	**7**	**11**	**0**	**2**	**4**	**24**
Indeterminate	111	33	0	3	19	166
Vertebrate	235	109	1	34	43	422
TOTAL	**825**	**658**	**22**	**237**	**264**	**2006**

A summary table breaking down the type of modification by class and percent of the modified bone that is attributable to each class is included in Table J-7. The class with the highest presence of cultural modification was mammal bone with 61 percent of the modified belonging to mammals (Table J-7). The class with the least cultural modification was fish accounting for just 1.5 percent of the culturally modified bone.

Table J-7. NISP of Cultural Modifications by Class at 41HM51.

Class	NISP Thermal Alteration	NISP Cut	NISP Chop	NISP Percussion	NISP Tool/ Other Cultural	Total NISP Modified	Percent of Bone with Cultural Modifications
Mammal	388	475	18	195	159	1235	61.57 %
Bird	12	20	0	0	9	41	2.04 %
Reptile	54	5	0	1	28	88	4.39 %
Fish	18	5	3	2	2	30	1.5 %
Vertebrate	235	109	1	34	43	422	21.04 %
Indeterminate	118	44	0	5	23	190	9.47 %
Total	**825**	**658**	**22**	**237**	**264**	**2006**	

Table J-8 breaks down each class by type of cultural modification. For instance, of the 1,235 mammal bones which exhibited cultural modifications, 38.46 percent of those had cut marks, 31.42 percent were thermally altered, 15.79 percent exhibited percussion impacts, 12.87 percent were a modified tool, and 1.46 percent exhibited chop marks.

Table J-8. Percent Modified (n=2,006) within each Class.

Class	Percent of Modified Bone with Thermal Alterations	Percent of Modified Bone with Cuts	Percent of Modified Bone with Chops	Percent of Modified with Percussion	Percent of Modified Tool/Other	Total NISP Modified by Class
Mammal	31.42 %	38.46 %	1.46 %	15.79 %	12.87 %	1235
Bird	29.27 %	48.78 %			21.95 %	41
Reptile	61.36 %	5.68 %		1.14 %	31.81 %	88
Fish	60.0 %	16.67 %	10.0 %	6.67 %	6.67 %	30
Vertebrate	55.69 %	25.83 %	0.24 %	8.06 %	10.19 %	422
Indeterminate	62.11 %	23.16 %		2.63 %	12.11 %	190

When broken down by associated temporal and cultural component, the Toyah occupational unit, which also has the highest frequency of bone overall, also had the highest presence of culturally modified bone (Table J-9). The Toyah component consists of 7110 fragments, of which 1481 (21 percent) had evidence for cultural modification. Unfortunately, given the paucity of bone within Late Archaic, Lower Toyah, and Upper Toyah levels, any assertions on lifeway differences between those levels are problematic.

Given the different nature of some of the cultural modifications, any modifications that were not associated with butchery or food production were further sorted out and are presented in Table J-10 below. As can be noted, the majority of the bone modified more for cultural use occurs within the Toyah component. Types of modifications are included in the table and a few examples are included in Figures J-5 through J-8.

Table J-9. Frequency of Cultural Modification to the Bone by Temporal Component at 41HM51.

Culture	NISP Thermal Alteration	NISP Cut	NISP Chop	NISP Percussion	Total NISP Modified	Percent of Total NISP Modified
Late Archaic	5	2	0	1	8	0.47 %
Lower Toyah	0	1	0	3	4	0.07 %
Toyah	808	651	22	230	1711	98.41 %
Upper Toyah	1	2	0	1	4	0.2 %
Unassigned	3	2	0	2	7	0.33 %
Indeterminate	8	0	0		8	0.53 %
TOTAL	825	658	22	237	1742	

Table J-10. Frequency of Non-butchery Modification to the Bone by Temporal Component at 41HM51.

Occupation	Type of Cultural Modification	NISP
Lower Toyah	Patina/Use Wear	1
	Subtotal	**1**
Toyah	Scraping	142
	Patina	21
	Use Wear	9
	Tool Use	8
	Bone Tool	1
	Grooving and Snapping	4
	Intentional reshaping	4
	Modified Bead	1
	Flute or Whistle	1
	Awl-like	3
	Cultural Abrasion Wear	1
	Other Cultural Modification	1
	Subtotal	**196**
Upper Toyah	Formed Sharp Edge/Use Wear	1
	Other Cultural Modification	1
	Subtotal	**2**
TOTAL		**199**

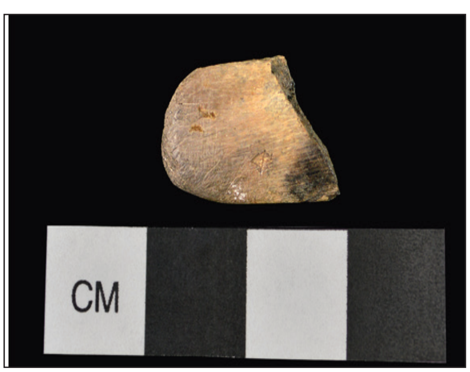

Figure J-6. Bone tool identified as medium or larger mammal…associated with the Toyah component in Test Unit 8 (Level 3).

Figure J-7. Possible bone whistle/ flute identified as a rabbit/small mammal associated with the Toyah component in Excavation Unit 20 (98.3-98.2 m).

Figure J-8. Expedient bone tool with abraded edge Bovidae long bone from lot 126 Feature 8, Test Unit 17.

Figure J-9. Deer proximal radius from lot 470 Toyah component exhibiting spiral fracture. View is of medio-anterior surface. Also note the percussion impact mark noted in profile on the posterior medial edge just distal to the proximal epiphysis fusion area.

Thermal Alteration

The color of the burned bones was recorded as an indicator of the degree of thermal alteration (Table J-11). Brown discoloration indicates short-term and lower heat burning, such as exposure to a grass fire or camp fire for less than six minutes (Lyman 1994). Blackened bone has been carbonized and would indicate prolonged exposure to a grass fire or camp fire. Grey and white bone has been fully calcined which means that it has lost all organic matter and become plastically deformed. Thermal alteration was by far the most prevalent modification on the bone (n=825; 41.13 percent of culturally modified bone, 10.78 percent of all bone in the assemblage). Of the 825 bones with thermal alteration, 101 exhibited brown discoloration, 421 had been blackened, 169 exhibited gray discoloration, and 129 had been fully calcined.

Thermal alteration included both direct burning of the bone which was exposed to fire and indirect modification of the bone from another heat source. It was noted during analysis that burning on a portion of the bones analyzed was superficial and did not go all the way through the bone. Brown discoloration is likely to be associated with roasting or the cooking of food that was not in direct contact with the fire. Brown discoloration (n=101; 12.24 percent of thermally altered bone) also indicates that the bone was only exposed to the heat source for a short period of time. Blackened (smoked) bone can occur from both cooking activities, direct contact with the fire, and accidental or unintentional nearness to an anthropogenic fire (Lyman 1994). The majority of thermally altered bone in this assemblage was blackened (n=421; 51.03 percent of thermally altered bone, 5.5 percent of all the bone in the assemblage). It is likely that blackened bone was associated with cooking and direct contact with the fire. In addition, bone that did not have black discoloration all the way through the bone could have had prolonged exposure to ash from the fire whether it be intentional or accidental. Gray discoloration and calcination occur with prolonged exposure to the heat source and the decomposition of organic material. Combined, gray and calcined bone make up over 36 percent (n=298) of the thermally altered bone. These bones' prolonged exposure to heat could be due to a couple of different mechanisms of burning, including the disposal of food waste or fuel for anthropogenic fires (Lyman 1994). However, it is more likely that small gray and calcined bone fragments were the result of discarding into the fire as a means of waste disposal. Though most of the thermally altered bone was likely associated with the cooking process, previous research (Jacobson 2014) has indicated that it is also possible that bone was being heated for the extraction of bone marrow and/or bone grease. The searing and weakening of the bone would make breaking the bone less labor intensive and make it easier to extract bone marrow and/or bone grease. However, if this was indeed the case, the bone would have a brown coloration

Given that even fragments of small turtle, small snake, small bird, opossum, pocket gopher, cotton rat, rat/mouse, squirrel, and small rodent had evidence for thermal alteration is suggestive that all species present at the site were subject to human consumption.

Table J-11. Thermal Alteration by Color/Degree of Burning.

Color	NISP Thermally Modified	Percent of Thermally Modified Bone (n=825)	Percent of Bone in Entire Assemblage (n=7653)
Brown	101	12.24 %	1.32 %
Black	421	51.03 %	5.50 %
Gray	169	20.48 %	2.21 %
Calcined	129	15.64 %	1.69 %
Indeterminate	5	0.61 %	0.07 %
Total	**825**		**10.78 %**

41HM51 Bone Breakage

Bone is a unique material in that it contains two major components: an inorganic component (primarily hydroxyapatite) that contributes to its rigidity and an organic component (primarily Type I collagen) that permits some degree of elasticity. After an organism's death, the organic component gradually decomposes, ultimately changing the biomechanical properties of the bone. Consequently, the form of bone fractures in "fresh" bone (i.e., that with higher amounts of collagen) often appear very different from fractures to more "dry" bone (i.e., where the majority of collagen has decomposed) (Lyman and Lyman 1994). In addition to distinguishing between fresh and dry breaks, fresh fractures types can be further divided into spiral and other green breaks (e.g., oblique fractures).

Spiral fractures are often the result of percussion impacts and are generally considered to be indicative of intentional cultural breakage (Figure J-8). Other green breaks may be produced by alternative taphonomic agents, such as carnivore gnawing. Carnivore gnawing can occasionally produce spiral fractures, but these spirals are typically distinguishable from human modification because they are overlain by splintering, jagged edges, or gnaw marks (Haynes 1983).

For this analysis, break types were recorded as spiral, green, dry, indeterminate, or unbroken. Indeterminate break types include those with fracture characteristics that were obscured by other taphonomic processes, such as abrasion, and those with mixed fresh and dry fracture characteristics. A small number of specimens are labeled as “fresh” where fracture characteristics indicate the break was fresh, but distinguishing between spiral and green breaks was complicated due to fragment shape or size.

A summary of the types and amounts of fragmentation across the site are available in Table J-12. The majority of faunal material at 41HM51 had some type of break (98.6 percent). At least 8.8 percent and as much as 9.4 percent of the assemblage had a spiral break indicating intentional breakage for marrow extraction. When divided by temporal component (Table J-13), this distribution is largely shaped by the Toyah component that contributes the majority of the faunal material. The proportion of spiral breaks in the Toyah component is relatively low when compared to the other cultural levels, while the proportion of indeterminate fracture types is relatively high. This may be due in part to the high prevalence of abrasion characteristics in the Toyah component, which can obscure fracture characteristics by smoothing fracture surfaces and rounding fracture edges, which in turn impacts the proportions of discernable break types (i.e., spiral, green, and dry).

Table J-12. Bone Breakage at 41HM51.

Type of Break	NISP	Proportion (%)
Spiral	670	8.8
Green	430	5.6
Fresh (Spiral or Green)	48	0.6
Dry	4145	54.2
Indeterminate	2250	29.4
Unbroken	109	1.4
Total	**7652**	**100.0**

Table J-13. Bone Breakage at 41HM51 by Temporal Component.

Temporal Component	n	% Spiral (n)	% Green (n)	% Fresh (n)	% Dry (n)	% Indeterminate (n)	% Unbroken (n)
Late Archaic	37	16.2 (6)	5.4 (2)	-	70.3 (26)	8.1 (3)	-
Lower Toyah	41	24.4 (10)	-	-	58.5(24)	17.1 (7)	-
Toyah	7110	8.8 (628)	5.5 (390)	0.6 (42)	53.0 (3769)	30.7 (2180)	1.4 (101)
Upper Toyah	30	40.0 (12)	-	-	43.3 (13)	16.7 (5)	-

When indeterminate fracture types are removed from consideration, breakage types in the Toyah component are more similar to the patterns observed in the Late Archaic component (Table J-14). In the Lower and Upper Toyah components, spiral breaks make up a much larger proportion of observed break types. This higher frequency of intentional breakage in the Lower and Upper Toyah cultural levels, together with the absence of unbroken elements, may indicate higher degrees of dietary stress and/or a reduced access to other animal fat resources during these periods.

Table J-14. Discernable Fracture Types at 41HM51 by Temporal Component.

Temporal Component	n	% Spiral (n)	% Green (n)	% Fresh (n)	% Dry (n)	% Unbroken (n)
Late Archaic	34	17.6 (6)	5.9 (2)	-	76.5 (26)	-
Lower Toyah	34	29.4 (10)	-	-	70.6 (24)	-
Toyah	4930	12.7 (628)	7.9 (390)	0.9 (42)	76.5 (3769)	2.0 (101)
Upper Toyah	25	48.0 (12)	-	-	52.0 (13)	-

Extensive fragmentation of larger bones suggest heavy bone processing, and consequently is another indicator for potential high levels of dietary stress. Long bones of medium to large mammals were often smashed by Great Plains groups to extract marrow and bone grease (White 1953, 1954, 1955; Kehoe and Kehoe 1960). The assemblage from 41HM51 contained a substantial portion of artiodactyl bones (n=1,664) including pronghorn (*Antilocapra americana*), deer (*Odocoileus* sp.), and large bovids (presumably *Bison bison*). The majority of these specimens were broken (n=1,599, 96.1 percent). Approximately 13 percent of specimens show evidence of intentional breakage (n=212). Unfortunately, small sample sizes of artiodactyl bone for the Late Archaic (n=5), Lower Toyah (n=5), and Upper Toyah (n=4) prevent a clear comparative picture of bone breakage patterns for larger mammals between cultural zones.

Taphonomy

Evidence for various taphonomic agents acting upon the bone and its ultimate preservation were noted in the field. While some of the dry bone breakage noted in the section above could have been caused by taphonomy, this section will focus specifically on other taphonomic factors.

Weathering

The degree of weathering to which a bone had been subjected was recorded for each bone. Degree of weathering was recorded following Lyman's (1994) synthesis of Behrensmeyer (1978), Andrews (1990), and Johnson (1985). The weathering scale consisted of rankings from 0 to 5 where 0 represents a bone with some flesh still attached and 5 would be a bone with large splinters which is disintegrating. Typically, all archeological material would be minimally assigned a 2 or 3 ranking. Typically, bone assigned a ranking of 5 was exposed to sun and the elements for a prolonged time prior to burial, whereas bones with a ranking of 2 or 3 would have been buried shortly after or at discard. Most (n=4184, 54.68 percent) of the bone recovered from 41HM51 was assigned a ranking of 3. Two bones were assigned a ranking of 1 (pocket gopher molar and kangaroo rat molar) but due to the resistant nature of tooth enamel to weathering it is difficult to definitively determine that these teeth are not associated with the deposit. However, because these are both burrowing rodents it is possible that they are intrusive. Of the remaining, 1813 bones were assigned a ranking of 2, 1355 bones a ranking of 4, and 241 bones a ranking of 4–5. Fifty-seven bones were not assigned a ranking due to burning which obscured degree of weathering, oversight, and indeterminate classifications.

It should be noted that of the 241 bones with a ranking of 4-5, 233 (96.7 percent) of those are classified as antler. Figures J-9 and J-10 compare the distribution of weathering scores of (a) all bone at the site and (b) all bone with antler excluded. The distribution remains largely stable when antler is removed, apart from the near elimination of weathering rankings of 4–5. Figure J-11 demonstrates the distribution of weathering for antler, only. Overall, the majority of antler at the site had a ranking of 4–5, but the distribution of other weathering ranks is similar in shape to the rest of the bone from the site.

Deer shed their antlers annually. Consequently, the advanced weathering of antler could indicate that the antler tines were naturally dropped and experienced a degree of weathering prior to being collected and used by individuals at the site. These antlers would not likely be collected for nutritional purposes but would instead be used to make tools or ornaments. Antler with lower degrees of weathering could indicate that it was brought to the site relatively fresh (e.g., on a hunted animal), and was likely not used after the depositional event.

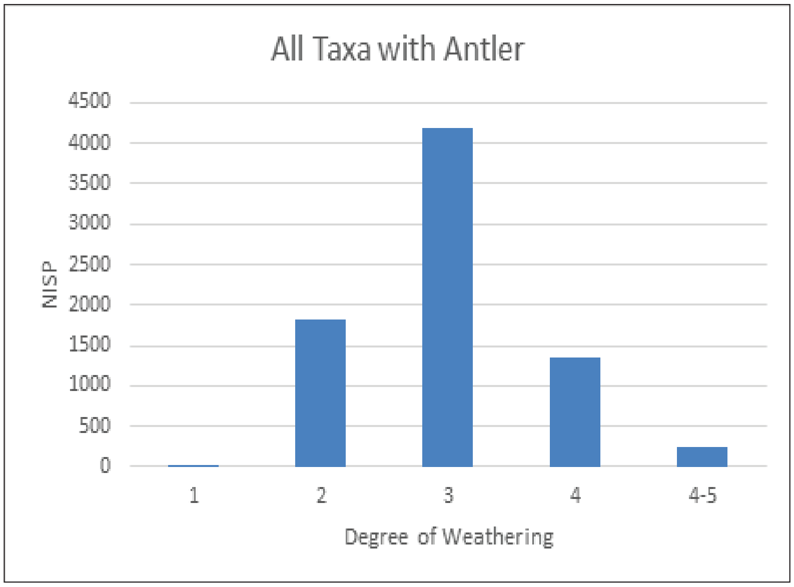

Figure J-10. Weathering of all taxa including antler.

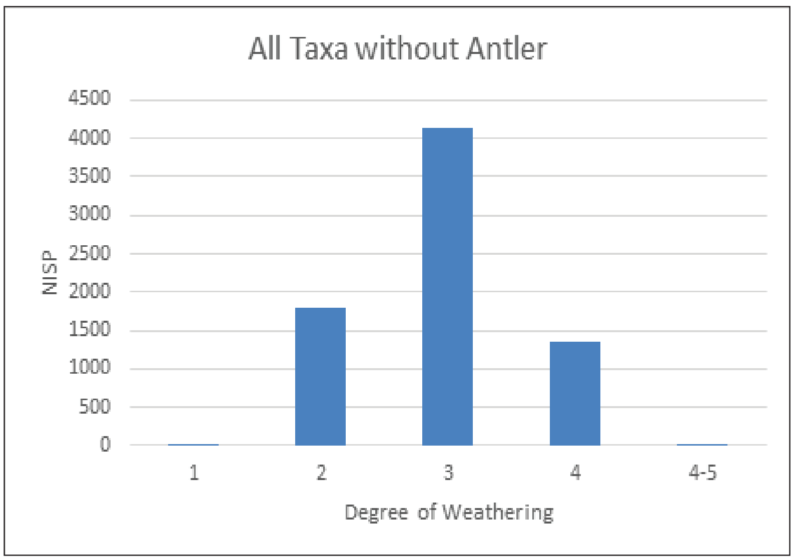

Figure J-11. Weather of all taxa without antler.

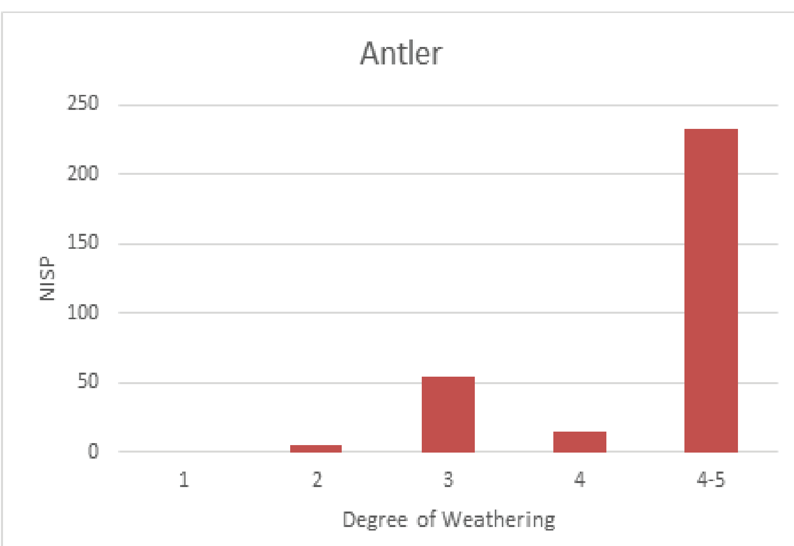

Figure J-12. Degree of weathering for antler.

The weathering distribution can inform depositional processes and occupation patterns at a site. Weathering patterns by cultural zones are detailed in Table J-15 and Figure J-12. Table J-15 also includes the weathering distribution for bone that could not be reliably assigned to a cultural zone, including the "unassigned" and "indeterminate" categories. Of interest, the "indeterminate" bone includes most of the bone ranked 4-5, all of which is antler. Fourteen additional fragments from the Toyah component scored 4-5, six of which are antler. Consequently, although the occurrence of highly weathered antler skews the weathering distribution as a whole, it has only a small impact on the analysis of weathering by identified cultural zone.

Table J-15. Degree of Weathering by Temporal Component.

Weathering	Late Archaic	Lower Toyah	Toyah	Upper Toyah	Unassigned	Indeterminate	Total
1	-	-	-	-	-	2 (0.62 %)	**2 (0.03%)**
2	21 (56.76 %)	12 (29.27 %)	1,646 (23.15 %)	16 (53.33 %)	44 (40.37 %)	74 (22.77 %)	**1,813 (23.69%)**
3	11 (29.73 %)	22 (53.66 %)	4,075 (57.31 %)	10 (33.33 %)	46 (42.20 %)	20 (6.15 %)	**4,184 (54.68%)**
4	5 (13.51 %)	7 (17.07 %)	1,319 (18.55 %)	4 (13.33 %)	19 (17.43 %)	1 (0.31 %)	**1,355 (17.71%)**
4-5	-	-	14 (0.20 %)	-	-	227 (69.85 %)	**241 (3.15%)**
N/A	-	-	56 (0.79 %)	-	-	1 (0.31 %)	**57 (0.74%)**
Total	**37 (0.48 %)**	**41 (0.54 %)**	**7,110 (92.92%)**	**30 (0.39 %)**	**109 (1.42 %)**	**325 (4.25 %)**	**7,652**

The weathering distributions of four identified cultural zones at 41HM51 are depicted in Figure J-12. Two general weathering distribution patterns occur. At a typical archaeological site, weathering is expected to be normally distributed around the average weathering score (i.e., a score of 3). This type of distribution occurs in the Lower Toyah and Toyah components, the latter of which includes the majority of faunal material recovered from the site. In contrast, the Late Archaic and Upper Toyah components are characterized by a high proportion of low weathering scores (i.e., 2), with the proportion of observed bone decreasing with increasing weathering score.

Unfortunately, very little bone was recovered outside of the Toyah component, making it impossible to say with certainty what caused these deviations from the expected pattern in the Late Archaic and Upper Toyah cultural zones. These differences could be due to processual activities, such as rapid deposition, which may in turn have implications for site use and occupation during these periods. There are potential cultural activity reasons for a lower weathering score. Less intensive human processing and cooking of bone may have resulted in less "weathering." Bone broken for marrow, but without being either roasted or boiled for grease extraction, would retain grease and would be less susceptible to weathering factors. The degree of onsite scavenging or carnivore modification could also have an effect, as canid-scavenged bone may have been left exposed for longer than intentionally-discarded bone, resulting in a higher degree of weathering. In absence of bone scavengers, human deposition would have resulted in faster coverage and less exposure to weathering characteristics. However, sampling bias cannot be ruled out given the paucity of data originating from the Late Archaic, Lower and Upper Toyah cultural zones.

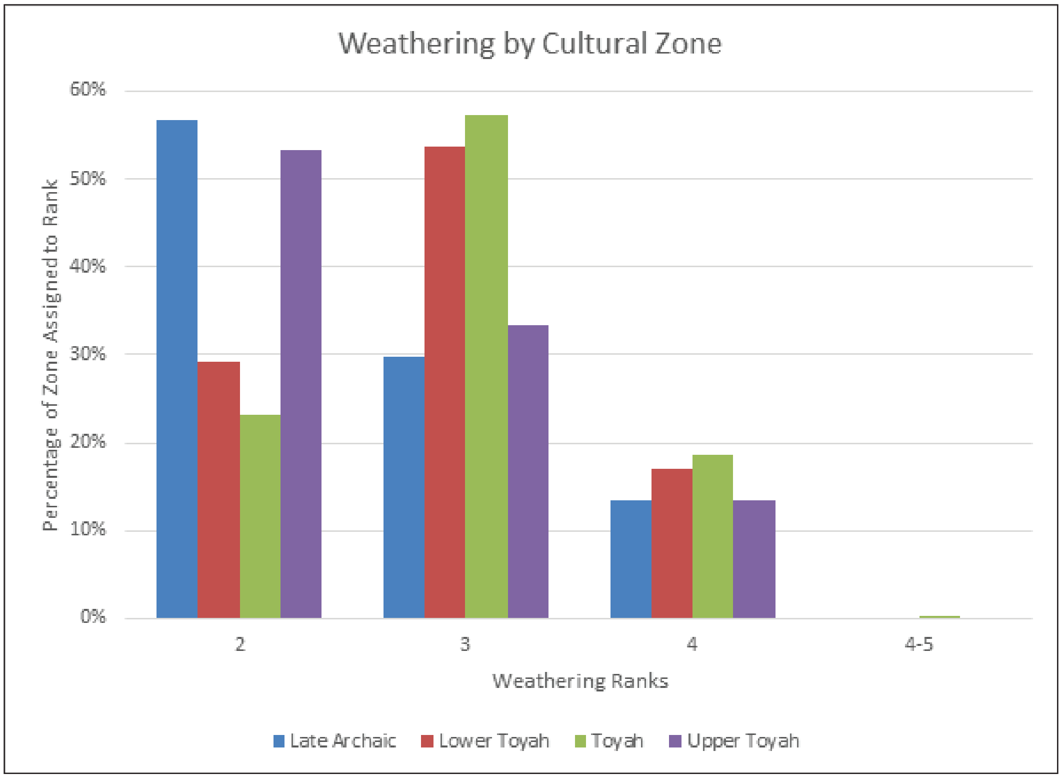

Figure J-13. Weathering by temporal component.

Alluvial Abrasion

Macroscopic characteristics of sedimentary abrasion include smoothing, polishing, and rounding. These characteristics appear when sedimentary particles suspended in wind (eolian abrasion) or water (alluvial abrasion) repeatedly impact bone, gradually reducing the cortical surface. Alluvial abrasion can generally be distinguished from eolian abrasion by the distribution of abrasion across a specimen, as abrasion due to water transport is generally distributed more evenly across a bone's surface, while eolian abrasion tends to be restricted to air-exposed surfaces (Shipman and Rose 1983). Sedimentary abrasion of bone tends to eliminate existing features or preexisting modifications, although it may occasionally produce marks that mimic carnivore pitting or scoring (Shipman and Rose 1983). Thompson et al. (2011) identified four different types of microscopic wear induced by sedimentary abrasion. Ablation involves the removal of material from the bone surface, obliterating or altering preexisting surface features or modifications. Cracking and pitting were defined as the appearance or expansion of surface fissures or non-linear features, respectively. Finally, displacement involved the lateral movement of material across the bone surface.

The effects of alluvial abrasion on bone are influenced by numerous variables, including the nature of the fluvial transport itself. Thompson et al. (2011) identifies three different transport modes: rolling bedload, saltation, and suspension. Rolling bedload transport occurs in slow-moving water, when the sediment is in constant contact with the bed. As water speed increases, sedimentary particles move via saltation, "hopping" across the bed, before becoming continuously suspended in the current. Thompson et al. (2011) found that the number of impacts between sedimentary particles and bone increased with increasing rate of flow, but that the degree of wear produced was lower in faster moving water due to temporary burial of the bone and the formation of scour pits in the bed.

All four types of microscopic wear were observed in archaeological bone subjected to sedimentary abrasion in the Thompson et al. (2011) experimental study, although the proportions of these types were affected by the flow rate and sediment transport mode. During rolling bedload transport, a high proportion (65.7 percent) of observed wear to the bone was categorized as displacement. When the bone was exposed to particles in saltation, virtually all observed wear was consistent with ablation. Wear on bone subjected to suspended particles was predominantly characteristic of ablation, although cracking and pitting were also observed.

Griffith et al. (2016) expanded on the work of Thompson et al. (2011) by examining the effects of sediment size class and morphology on the rate and microscopic characteristics of alluvial abrasion. Griffith et al. (2016) found that in very small sediment classes (silt or fine sand, <152.5 µm on average), displacement was the most common form of microscopic abrasion observed, resulting in a smoothed appearance. In larger sands and gravels, ablation was the most common observation, often facilitated by accumulating networks of cracks. Generally, larger sediment classes had higher abrasion rates, producing more abrasion during the experimental period. However, the results of this study suggest that this relationship is complicated by the angularity or sphericity of sedimentary particles (Griffith et al. 2016).

Characteristics intrinsic to a bone or fragment can also moderate the effects of alluvial abrasion. Archaeologists have observed that weathered bone is more susceptible to break and abrades more quickly during fluvial transport, likely due to the reduction of bone integrity associated with the degradation of bone's flexible, organic component – collagen (Behrensmeyer 1990:234, Martill 1990:282). Similarly, bones that have been boiled are also more susceptible to abrasion (Nicholson 1992). Thompson et al. (2011) also demonstrated the reduced resistance of boiled bone to alluvial abrasion. The "fresh" bone samples used in that study were boiled to remove soft tissue, which resulted in an increased abrasion rate when compared to weathered and archaeological samples.

Research has also suggested that bone composition, which varies between taxa, may also influence a bone's susceptibility to alluvial abrasion. Nicholson (1992) found that for standardized samples of haddock (*Melanogrammus aeglefinus*) and sheep (*Ovis aries*) bone, haddock bone disintegrated rapidly when subjected to tumbling in pebbles and ball bearings whereas sheep bone retained their integrity. Frog (*Rana temporaria*) bone also appeared to be unusually resistant to alluvial abrasion when compared to similar elements from various fish and mice (*Mus* sp.), although it is unclear whether this is due to differences in bone composition or bone shape (Nicholson 1992). Dense, robust elements of fish (e.g., dentary, premaxilla, quadrate) and spherical elements (e.g., vertebrae, astragali) were observed to be more resistant to alluvial abrasion (Nicholson 1992). Unfortunately, little if any additional research has explored the relationship between alluvial abrasion and intrinsic variables such as bone composition, density, and morphology (Figure J-13).

Figure J-14. Example of bone fragment with abrasion characteristics.

Evidence of abrasion was not initially recorded, but observations of macroscopic abrasion characteristics were incorporated later in the analysis given their prevalence. The presence or absence of abrasion characteristics were recorded for approximately 60 percent of the assemblage (n=4506). When only specimens for which abrasion characteristics were recorded are considered, 18.5 percent of the assemblage had at least one abrasion characteristic. The frequency and proportion of the assemblage displaying individual abrasion characteristics are recorded below in Table J-16. Rounding, especially of fracture edges (Figure 13), was the most common followed by polishing and smoothing of features.

Table J-16. Abrasion Characteristics in 41HM51.

n=4506	Frequency	Proportion of Recorded Assemblage (%)
Smoothing	293	6.5
Polishing	391	8.7
Rounding	489	10.9

Because abrasion characteristics were not recorded for the total assemblage, the impacts of abrasion were not recorded equally in all occupation levels. Abrasion characteristics were not recorded at all for fauna from the Late Archaic or Lower Toyah occupation levels, although the presence of abrasion characteristics were recorded upon review of 4 specimens from the Lower Toyah level. For the Toyah occupation, abrasion characteristics were recorded for about 60 percent (n=4439) of specimens, and all specimens from the Upper Toyah occupation (n=30) were reviewed for abrasion characteristics. Abrasion characteristics were only recorded for a small proportion (n=10, 20.0 percent) of fauna from unassigned occupations, although the presence of rounding or polish was retrospectively entered upon review of comments for a few specimens. Due to this unequal recording, abrasion can only be discussed in depth for the Toyah and Upper Toyah occupations.

In the Toyah component, 812 specimens (18.3 percent) had at least one abrasion characteristic. Given that the Toyah component makes up the majority of the assemblage (92.9 percent), the frequency and proportions of smoothing, polishing, and rounding observed are comparable to those presented for the overall assemblage. Two or three abrasion characteristics were observed on 290 specimens (6.5 percent) from the Toyah assemblage. In the Upper Toyah component, only five specimens (16.7 percent) had any abrasion characteristics, and 2 had both smoothing and polishing (6.7 percent).

It is possible that some of the smoothing, polishing, and rounding observed in the assemblage is due to alternative cultural or taphonomic agents such as tool use or carnivore modification. Of the 833 specimens with abrasion characteristics, 68 (8.2 percent) have additional evidence of intentional cultural modification such as scraping, patina, or use wear that could impact the prevalence of abrasion characteristics. Similarly, 367 fragments with abrasion (44.1 percent) also had evidence of carnivore modification including mechanical or chemical digestion. Just under half (n=395, 47.4 percent) of specimens with abrasion characteristics had no evidence of cultural or carnivore modification. Consequently, between 8.8-18.5 percent of the faunal assemblage may have been impacted by alluvial activity. This is consistent with the presence of an alluvial drape observed over the Toyah component during excavation.

Ultimately, our analysis of alluvial abrasion at 41HM51 was limited to macroscopic characteristics of abrasion. However, a microscopic analysis of the abrasion types used by Thompson et al. (2011) and Griffith et al. (2016) in conjunction with geomorphological data may yield further insight into site formation processes.

Rodent Modification

Rodents had gnawed on 318 of the bones recovered from the site. Two-hundred and seventy bones had been gnawed by smaller rodents such as mice, rats, or voles, while forty bones had been gnawed by larger rodents such as squirrels. Research has shown that brown rats tend to gnaw bone which is fresh and still laden with fats, while squirrels instead target thicker bone cortices once fats had leached away (Klippel and Synstelien 2007). Consequently, rats will gnaw on bones recently deposited while squirrels are more likely to gnaw on bone left exposed for a prolonged time. An example of a rodent-gnawed rib fragment is presented in Figure J-14.

Given the much higher distribution of bone gnawed upon by rat and mouse presented in Table J-17, it is suggested that the site was rapidly buried and thus bone was not frequently left exposed on the surface. Given the alluvial drape associated with the Toyah component, frequent flooding and rapid deposition would be in keeping with other site data. Unfortunately, because most rodent-gnawed bone is associated with the Toyah component (97 percent of all rodent gnawed bone recovered) and there is so little bone associated with the other cultural levels (one bone or less per assignable cultural unit), an in-depth discussion regarding differences in degrees of gnawing of fresh bone (mouse/rat) or dry bone (squirrel) between timeframes is not possible at this time. A brief summary of this data is presented in Table J-18.

Figure J-15. Rodent-gnawed fragment of artiodactyl rib from lot 720 of the Toyah component.

Table J-17. Percent with Rodent Modification within the entire assemblage (n=7653) by Rodent Size

Rodent Size	NISP Modified	Percent of Rodent Modified Bone	Percent of Bone in Entire Assemblage
Mouse	37	11.64 %	0.48 %
Rat	233	73.27 %	3.04 %
Squirrel	40	12.58 %	0.52 %
Indeterminate	8	2.52 %	0.1 %
Total	**318**		**4.16 %**

Table J-18. Frequency of Rodent Modification to the Bone by Temporal Component at 41HM51.

Culture	NISP Mouse	NISP Rat	NISP Squirrel	NISP Indeterminate	Total NISP Modified	Percent of Total NISP Rodent Modified
Late Archaic	-	-	-	-	-	-
Lower Toyah	0	1	0	0	1	0.31 %
Toyah	36	226	39	8	309	97.17 %
Upper Toyah	0	1	0	0	1	0.31 %
Unassigned	0	5	1	0	6	1.89 %
Indeterminate	1	0	0	0	1	0.31 %
TOTAL	**37**	**233**	**40**	**8**	**318**	

However, the characteristics of rodent gnawing observed within the Toyah component may indicate a long-term occupation of the site during this period. Of the rodent-gnawed bone from the Toyah component, most (73.14 percent) is consistent with gnawing by rat-sized rodents (Table J-18). As more omnivorous than mice or squirrels, rats may be attracted to the accumulations of human refuse that result from prolonged occupation and may have served as commensal pests feeding on a supply of dependable fresh refuse.

Carnivore Modification

Of the 7,653 bones recovered from the site, 1,443 bones, approximately one-fifth (19 percent) of the entire assemblage demonstrated signs of carnivore modification. Signs of modification included gnaw marks and scoring/pitting, puncture marks from the canines, scrapes from incisors, and the polish, striations, and angled but abraded edges consistent with scatological or other digestive erosion. (See example in Figure J-15.) The most prevalent type of modification involved carnivore gnawing on the bone including 364 bones with gnaw marks and 927 additional bones exhibited pitting, scoring, or crushing. A smaller percent (n=60) exhibited puncture marks and 101 bones were scatological or subject to partial digestive erosion.

Figure J-16. Bovid first phalanx with carnivore modification associated with the Toyah component, Excavation Unit 90 (97.7-97.6 m).

Of 1,443 bones exhibiting carnivore modification, 428 (30 percent) were artiodactyls. There were 1,656 artiodactyl bones at the site as a whole; approximately 26 percent of all artiodactyl bones recovered from the site exhibited carnivore modification. It is rare for sites with overlapping temporal components in Texas and similar regions to have such a high degree of carnivore modification. For instance, the Siren Site in Williamson County had similar evidence of high bone breakage and an assemblage of over 17,000 bones at a transitional Late Archaic to Late Prehistoric site. Only 0.03 percent of the bone from Siren Site showed evidence of carnivore modification. The Fish Creek Slough Site in Dallas County dated from A.D. 1270 through contact to the historic period and had over 8,700 bones, only 0.8 percent of which showed signs of carnivore or rodent modification. Therefore, the high degree of carnivore modification is significant and is suggestive of something more than scavengers lurking around a site or raiding middens. Furthermore, many of the carnivore modified bones also exhibited cultural evidence including one that had been burned after the gnawing event. Another had sharp angular breaks typical of canids, with one edge abraded by use as an expedient tool the other edge still sharp, suggesting that the rounded edge had not been modified by alluvial abrasion. Such evidence suggests the existence of a closer relationship between dogs and humans at the site.

Morey and Klippel (1991) documented a high degree of carnivore modified deer bone at a site in East Tennessee, the Hayes Site (40ML139), a Middle Archaic Shell Midden site with a presence of dog burials. Greater than 25 percent of the deer bone at the site had evidence of carnivore modification. In addition, they conducted actualistic studies feeding deer bone to a large domestic dog. They both picked up abandoned remains and retrieved bone from scat. They also found that the dog was able to efficiently fully consume softer spongy bone such as the pelves and the epiphyses of long bones, but shafts were frequently left behind. While not fed vertebrae, the vertebrae of deer and bison is similar in texture as the pelvis and as a bone with minimal bone grease return may have been discarded once meat had been successfully removed. The high degree of carnivore modification (26 percent of all artiodactyl bones) at 41HM51 strongly suggests the presence of domesticated dogs.

It is well documented that the various groups on the Plains had domesticated the dog for a variety of purposes, including as hunting assistance, pack animals, personal protection, and as a food source. Numerous ethnohistoric sources (Winship 1896, Hammond and Rey 1940, Swanton 1942) describe Texas groups such as the Querchos and Teyas as using dogs for pack animals pulling a travois as they followed bison. There are also early ethnohistoric accounts of the Caddo (Sibley 1922; Indian Affairs 1832; Swanton 1942) raising domesticated dogs. Some accounts suggest that "Before their contact with Europeans the Caddo had no domestic animals except the dog, and that was eaten, if at all, only on ceremonial occasions and in times of famine" (Swanton 1942:134). A specific description for Caddo dogs states that they had "some dogs also which they call jubines because they are a mixture of dog and coyote or wolf." (Solis, 1931:61; Swanton 1942:134). Morfi (1932) references that the jubines were raised for hunting both "buffalo" and bear and used in hunting to give chase (Swanton 1942) and that the western Caddo would hunt both buffalo and bear in winter (Swanton 1942). There have been other Caddoan links at 41HM51 discussed elsewhere in this report.

Figure J-17. Canid metacarpal from 41HM51 (top) compared to metacarpal from a contemporary domestic dog (bottom). Metacarpal associated with the Toyah component from Test Unit 17, Level 3.

There were a total of nine Canis sp. bones recovered from the site and an additional four Canidae bones. While none of the canid bones present had features present to allow definitive identification as coyote or domesticated dogs, some of the bones were larger than coyotes yet smaller than wolves (Figure 16). Wolves do not range in Texas, yet Indian Dogs bred as pack animals were typically larger than an average coyote. As the comment above stated, the jupines tended to be larger animals frequently mixed with wolf. A metacarpal bone (Figure J-16) was significantly larger than the dog and coyote in the CAS collection, so it was taken to UT's Vertebrate Paleontology Lab to compare with other large dogs, wolves, and other large carnivores such as mountain lion and bear. Characteristically it was definitively canid yet was larger than the coyote and too small for a wolf. Given the other evidence, the argument for presence of domesticated dog is strengthened.

Taphonomy Summary

Despite the fact that most of the bone (n=6,395; 83.6 percent) exhibited dry (post-depositional) or indeterminate (unknown whether just post-mortem or post-depositional) breaks, the bone from 41HM51 was more identifiable and better preserved than most assemblages in Texas. The minor presence of advanced weathering of the bone combined with the overall preservation of the bone also suggests relatively fast burial of the material, which is further supported by the high frequency of specimens with characteristics of alluvial abrasion and the presence of an alluvial drape over the predominant cultural level (Toyah). There was a considerable degree of scavenging by rodents and carnivores after human butchering. Last, taphonomy alone cannot be responsible for skeletal part frequency differential distributions of the major prey species at the site. There is some evidence for transport and selective choice of elements.

Skeletal Part Frequencies

Skeletal part frequencies can be used to infer butchering, transport, food preparation, disposal habits, nutritional analysis, activity areas, site function, economic institutions, and social organization (Reitz and Wing 1999). Researchers (Read 1971, Styles 1981) have proposed that bones of large animals may not be transported from the kill site to the habitation site and the likelihood of differential conveyance increases with the animals' distance from the habitation site. White (1952) posited that not all parts of a large animal, such as bison, would have been brought back to camp. He stated that "Since the lower limb does not carry any useable meat it is conceivable that is was chopped off and left at the place of kill to reduce the load" (White 1953: 162).

Skeletal part frequency analysis is useful in not only determining potential site function (kill site versus habitation site) but can provide additional insight. Skeletal part frequencies can help researchers infer taphonomic conditions, for instance when less dense bones such as vertebrae may be present in lower frequency than dense bone such as long bone fragments. They provide information about the archeological site's ecological surroundings. If there are different frequencies of high versus low utility bones for similar sized species which inhabit different habitats, the case may be made that one of those species is being locally obtained while the other may be coming from a greater distance. Skeletal part frequencies can also aid in understanding the relationship between human subsistence strategies and dietary stress, for instance, if only high utility "gourmet" parts were present of select species versus highly processed lower utility parts.

As large bovids (cow and bison) and cervids (white-tailed deer and mule deer) were the most prevalent typical prey species, an examination of skeletal part frequencies was conducted. Pronghorn antelope, while similar sized to deer, were only minimally represented (n=4) in the assemblage and were represented by no more than one animal (MNI=1). Given the paucity of pronghorn bones, a separate analysis of their skeletal part frequencies was not included as any discussion would be lacking in relevance. However, as many pronghorn elements could be confused with deer in a fragmented state, which could skew interpretations of skeletal part frequencies, an analysis of medium-large artiodactyl skeletal part frequencies is also presented.

Figure J-17 depicts different trends in skeletal part frequencies for bovids and cervids. Cervids have a much higher frequency of lower utility elements, namely cranial and tarsals and phalanges, while bovids have a higher frequency than deer of high and middle utility parts, most predominantly ribs. Both the full skeletal part frequencies in Figure J-17 and the following Figure J-18 suggest a standard "bulk" carcass unit recovery strategy for deer and a gourmet carcass unit recovery strategy for bovids, per Binford (1978) and Emerson (1990). This difference suggests that all parts of the deer were brought back to camp and were therefore hunted nearby. The cranial bones are larger and far less fragmented for deer than other long bones. As will be discussed later, there was also a high degree of carnivore modification to the bone. Softer spongy bone, such as vertebrae, pelves, and ribs, are more likely to be fully consumed and destroyed by canids when scavenged. The low fragmentation and high preservation of less dense cranial fragments while more dense long bones have high fragmentation suggest all bones may have been brought back but were differentially processed upon return.

In contrast, missing bovid bones are those that are of lower utility while also being heavier and more difficult to transport, such as the skull. Given the high presence of less dense cervid cranial bones (Figure J-19), the lack of bovid cranial bones is not due to taphonomic causes such as carnivore modification, acidic soil conditions, alluvial abrasion, or other factors. This would likely indicate carcass units were specifically selected for transport back to the site based on nutritional value and return. One high utility grouping under-represented amongst bovid bones are vertebrae. Meat along the vertebrae can easily be stripped and removed and dried for jerky or eaten fresh.

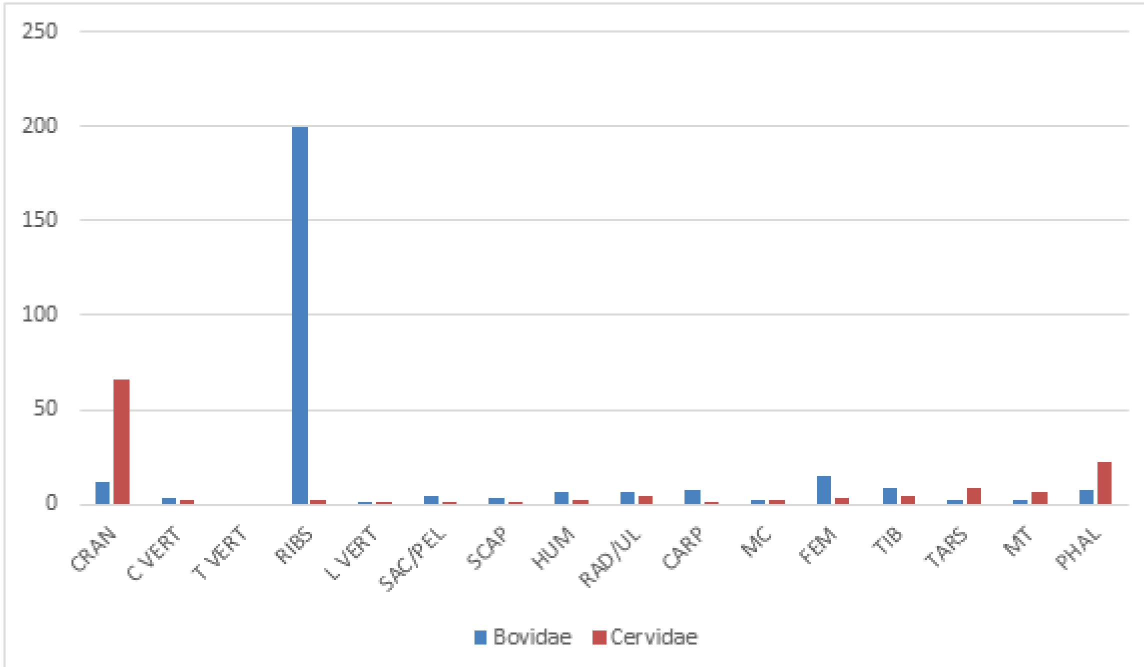

Figure J-18. Distribution of skeletal fragments for bovids and cervids recovered from 41HM51 data recovery excavations.

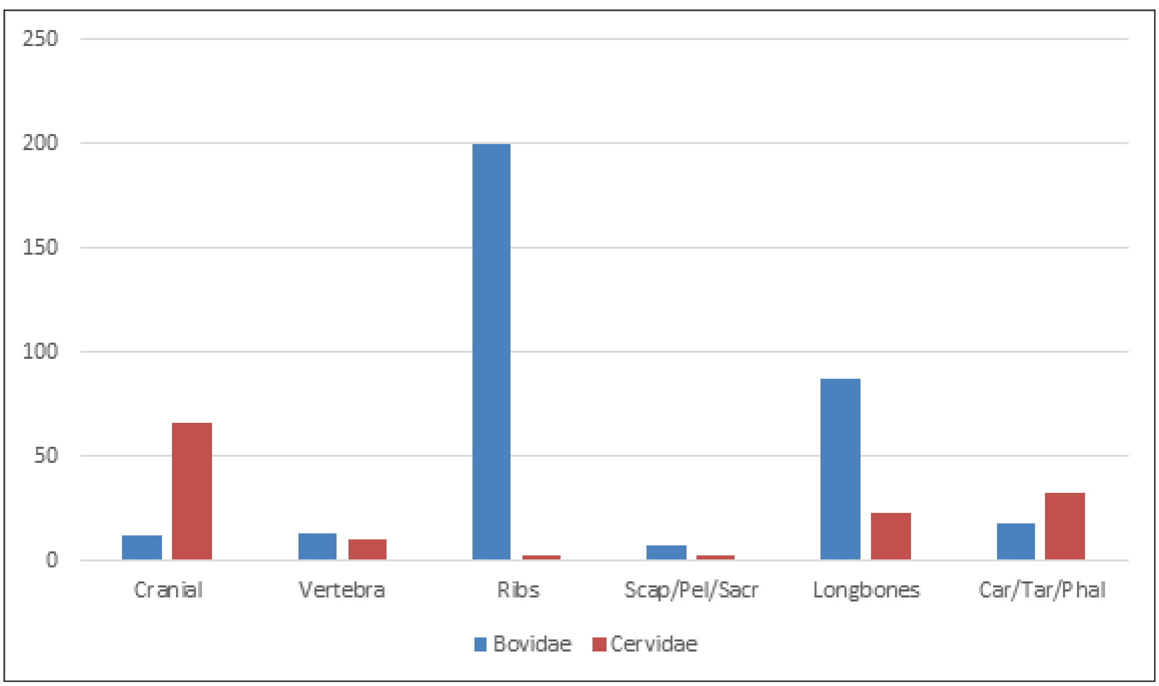

Figure J-19. Distribution of skeletal elements by general unit designations.

Figure J-20. Abundance of deer maxillary (top) and mandibular (bottom) fragments from 41HM51.

It is possible that bison vertebrae could have been ravaged by canids as well and their lack could have taphonomic as well as cultural causes. The meat along ribs is not easily removed and occurs within the spaces between ribs. More return would come from disarticulating or chopping large sections of ribs to remove them in sections and transporting them back to site. Rib bones would have a similar density as thoracic dorsal spines; yet rib bones occur in large numbers at the site while thoracic dorsal spines are lacking in any significant numbers. This difference in skeletal part frequencies between the two suggests cultural reasons for the high presence of rib bone. In contrast, a few low utility bones were transported to the site, namely long bone elements. To discern whether this was related to their potential to provide marrow or other bone grease, Emerson's (1990) designations based on bison marrow and grease utility for limb bones are compared to the bovid long bone skeletal elemental presence from 41HM51. It would appear that there are differences in the presence of deer and bovid elemental presence. Many Plains groups would range far to collect bison, especially after use of domesticated dogs and later horses were introduced to aid in transport of carcass units back to habitation sites.

In order to make sure that the deer bone skeletal part distribution is truly representative and not an artifact of some harder to differentiate to species element(s) being left out of distribution plots, the deer data was replotted against artiodactyls. Due to the similarity between pronghorn antelope and deer, some deer bone fragments may have been left at a broader "artiodactyl" taxon level. While a total of 231 bones could be determined to be either pronghorn or deer, given that only four bones in the assemblage were definitively assigned to pronghorn, while 448 bones were assigned to deer, it is assumed that the majority of the undifferentiated pronghorn/deer bone likely would be associated with deer. Remarkably, the distribution of pronghorn/deer elements is very similar to that of deer with two primary differences, cranial and rib representation. The frequency of cranial elements is much higher in elements discernable to at least deer. This is likely due to the fact that overall cranial fragments tend to be more identifiable to species, especially when considering teeth comprise some of the cranial elements. Ribs, in contrast, are incredibly similar between pronghorn and deer and fragmentary ribs would be very difficult to identify to species Figure J-20).

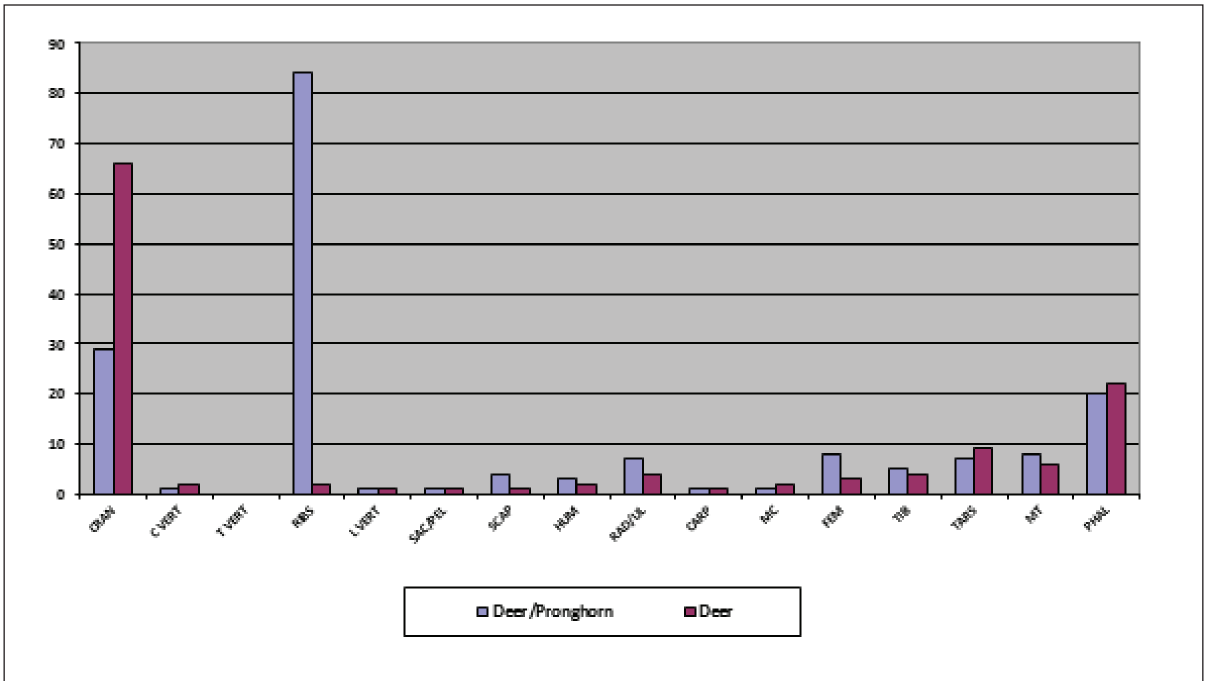

Figure J-21. Skeletal part frequency for artiodactyls identifiable as either deer or pronghorn contrasted with elements identifiable specifically to deer.

A second data set including some elements identified to a broader elemental category (such as metapodial instead of metacarpal or metatarsal, vertebrae instead of cervical, thoracic, or lumbar vertebrae) was developed to look at broader distributions of pronghorn/deer to deer ratios and is presented in Figure J-21. Given the frequency at which each element occurs in the body as presented in Figure J-22, when taken together, the pronghorn/deer and deer combined represent more of an unbiased carcass unit recovery strategy per Binford (1978) and Emerson (1990), with the exception of vertebrae. Essentially this means that bones are present in a similar frequency to which they occur, suggesting animals were killed nearby, all elements brought back, and taphonomic factors acted equitable on all elements. While a similar lack in vertebrae in large bovids may be explainable by stripping meat and leaving heavy vertebrae behind along with heavy low utility bones, the same absence of vertebrae in deer and pronghorn deer while similar density bones survive requires more investigation. Highly fragmented bone broken for bone grease is usually still identifiable as at least axial (e.g. vertebrae, pelvis, ribs) or appendicular (limb elements, Figure J-21). The absence of vertebrae may be related to carnivores. Experimental studies have shown that canids tend to fully consume most spongy bone elements such as vertebrae and pelves (Haynes 1983, Morey and Klippel 1991).

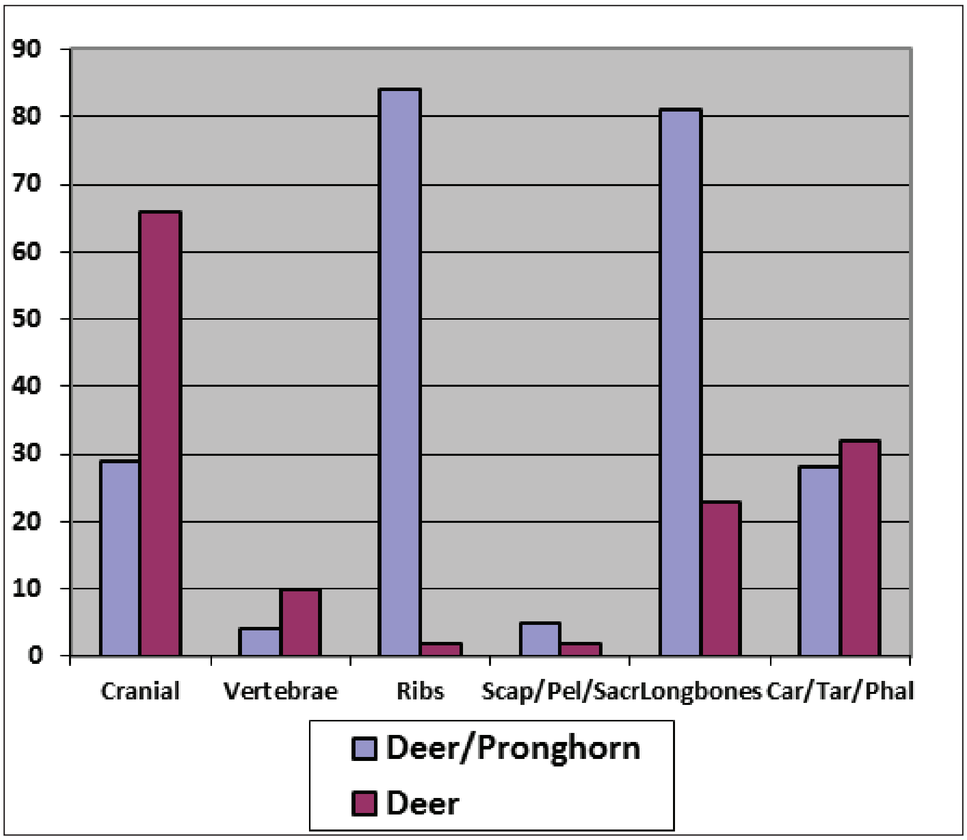

Figure J-22. Skeletal part frequency of elemental categories.

Mule Deer versus White-tailed Deer

Variations within cervid species were also examined to determine if there were differences between mule deer and white-tailed deer. While the two species have been known to ecologically overlap and even hybridize, their preferred habitats are different. Differences in skeletal part frequencies could indicate differences in hunting strategies or local availability of the two species. Figure 22 contains a breakdown of skeletal elements recorded for both species from the site. The primary means of differentiating between skeletal remains are related to limb bone morphology and were developed by Jacobson (2003, 2004). Additional work differentiating between carpal and tarsal bones of many artiodactyls, including mule deer and white-tailed deer, were developed by Ford (1990). Discussion of differences in skeletal part frequencies is focused on limb elements which are discernible to species.

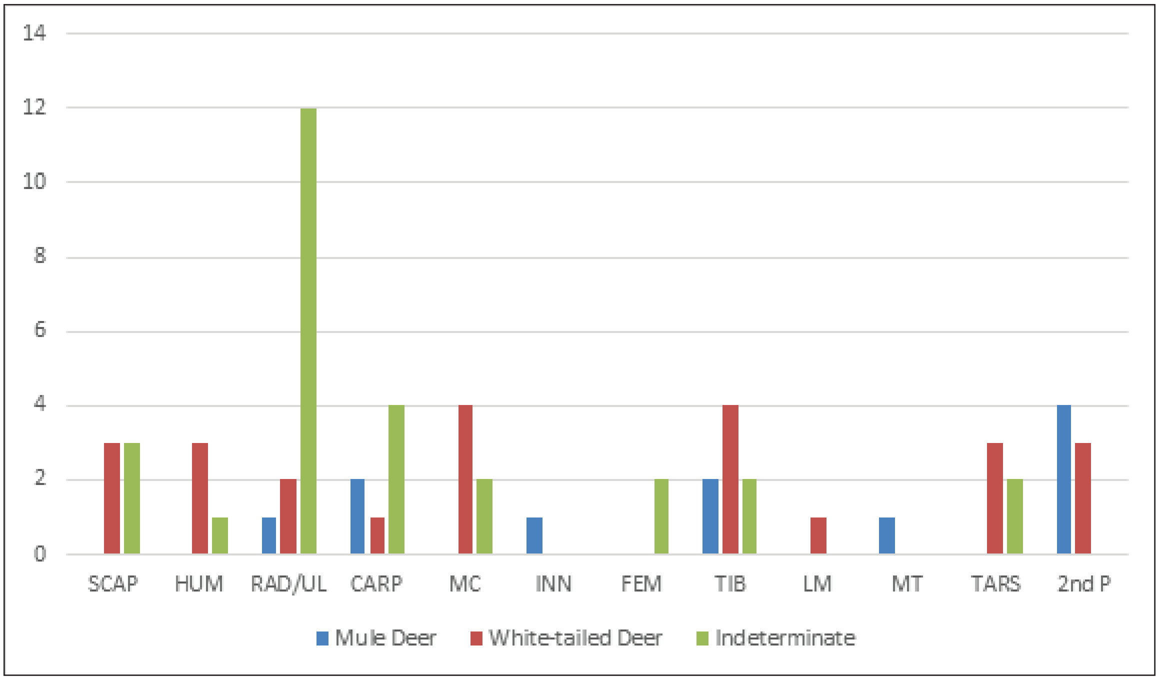

Figure J-23. Distribution of forelimb and hindlimb skeletal fragments for mule deer, white-tailed deer, and indeterminate deer from 41HM51 data recovery excavations.

Jacobson (2000) developed elemental unit groups related to utility and their frequencies which are presented in Figure J-23. When contrasting the presence of bone elements recovered from 41HM51 by utility unit for all deer (Figure J-24), data suggest that deer would have been either killed near the site, or all bones from the deer were transported to the site if lumping all species of deer together. Figure J-25 removes indeterminate deer and plots the elements associated with each utility unit divided by species designation. Most high utility elements for deer have few characteristics identifiable to species in contrast to low utility. In general, similar trends are noted at this gross level of examination for both mule deer and white-tailed deer, with the exception of the relationship of middle to low utility parts. There are fewer low utility mule deer elements present than white-tailed deer, but overall in keeping with a pattern of complete skeleton presence.

As identification techniques to differentiate between mule deer and white-tailed deer are primarily limited to long bones and cranial bones (incisors and lacrimal foramen), greater interpretation on transport and site niche utilization is difficult with overall bone element presence. Therefore, utility of elements based on marrow and bone grease composition for deer species are compared with deer recovered from the site. Based on Jacobson (2000), the elements with the high utility for marrow and bone grease are the tibia and femur, those with middle utility include the metatarsal, humerus, and radius, and that with lowest utility is the metacarpal. The frequencies at which each element occurs within each utility unit is presented in Figure J-26.

Limb elements related to utility unit recovered from 41HM51 were sorted based on utility for marrow and bone grease (Figure J-27). The results suggest an equal distribution of high, middle, and low utility marrow and bone grease elements for mule deer. Given each are represented by only one bone, the data is limited. White-tailed deer have a higher frequency of high and middle utility elements present than low utility (Figure J-27). But when all are combined the presence follows primarily the utility distribution curve if the entire animal were present, with a slightly reduced presence of low utility bones (Figure J-28).

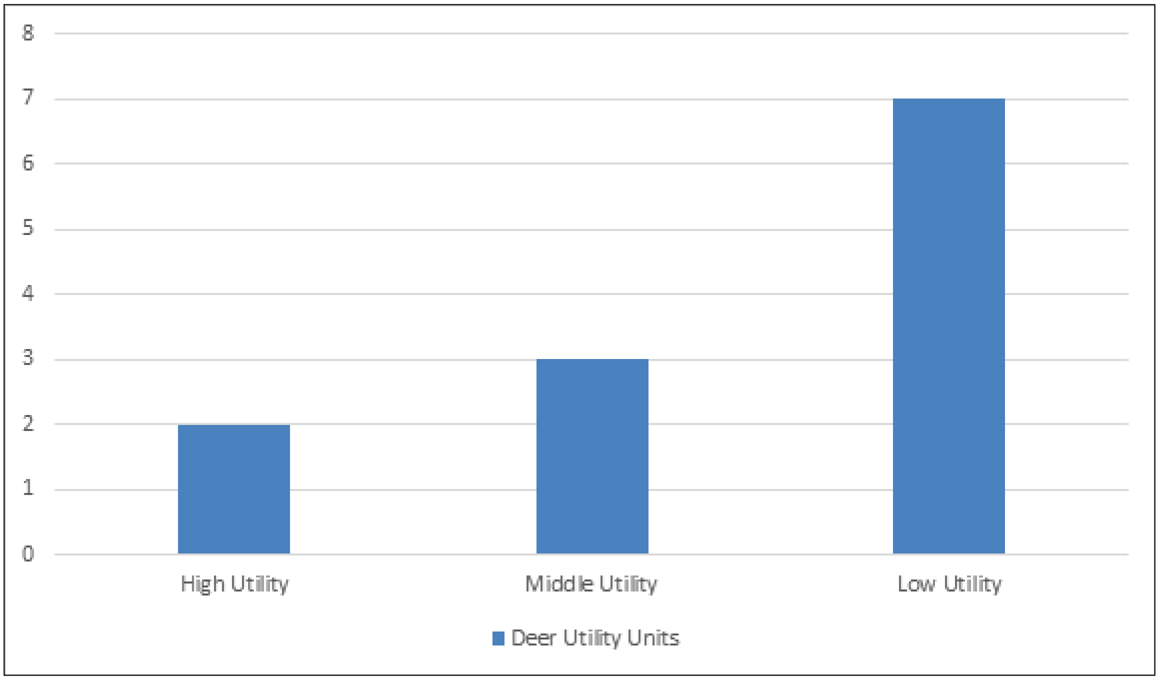

Figure J-24. Average utility (from Jacobson 2000) distribution for deer elements.

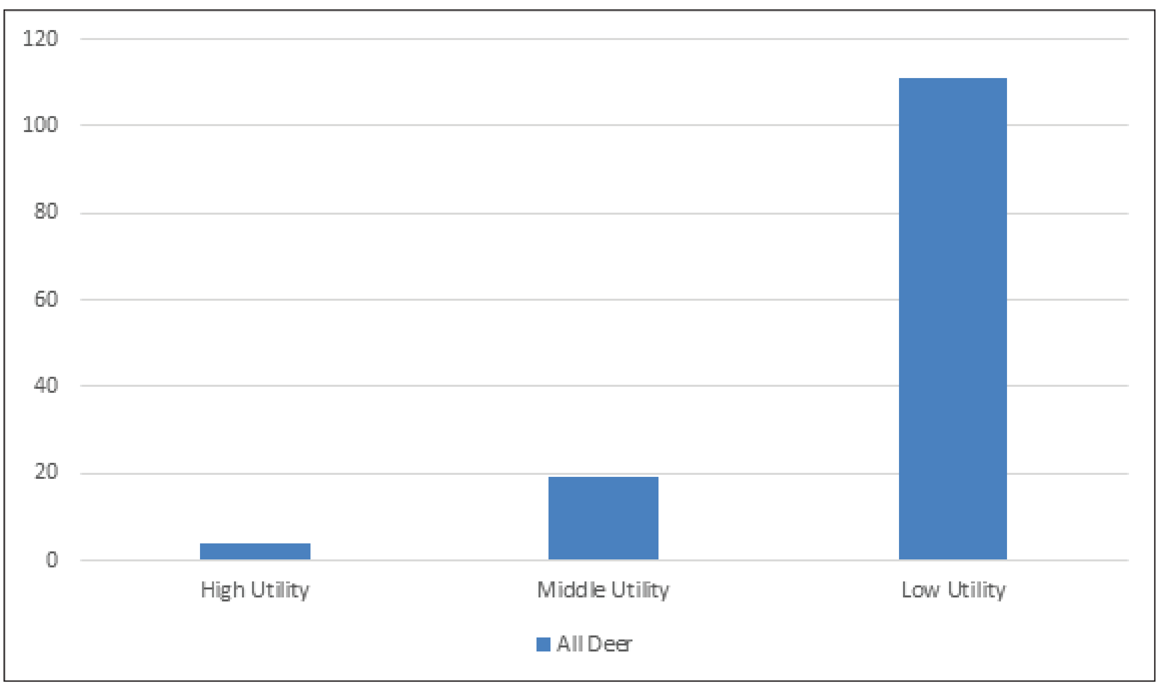

Figure J-25. All Odocoileus bones identifiable to O. virginianus, O. hemionus, and O. sp., except for antler.

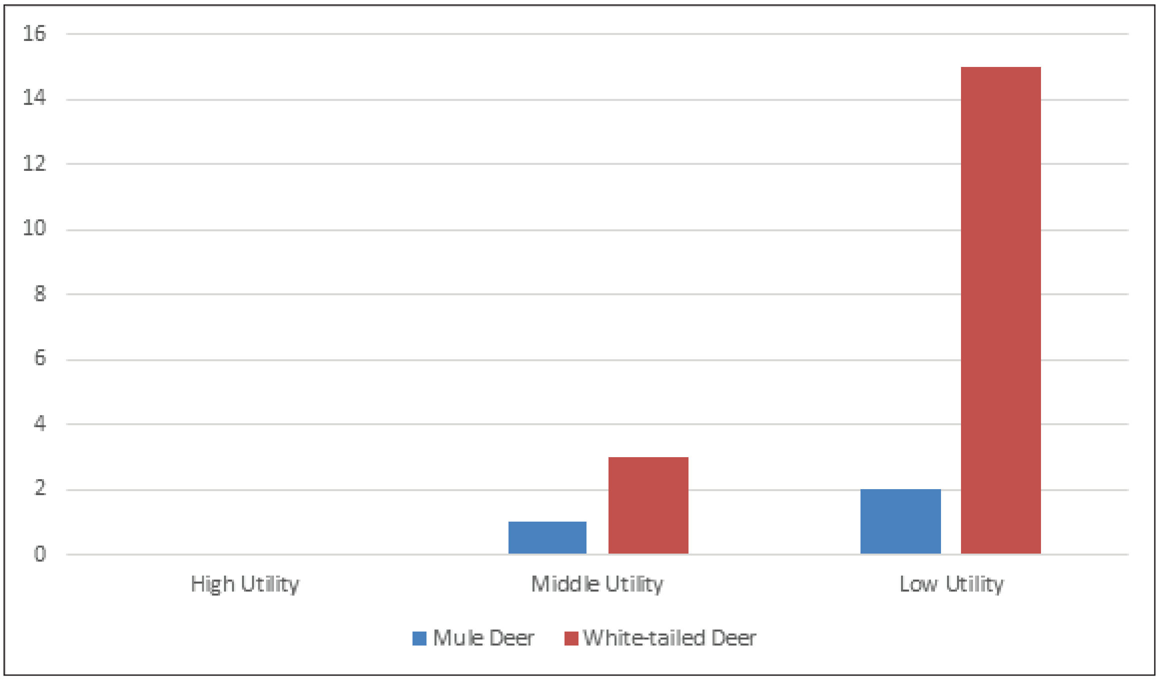

Figure J-26. Mule deer and white-tailed deer element utility distribution for general utility.

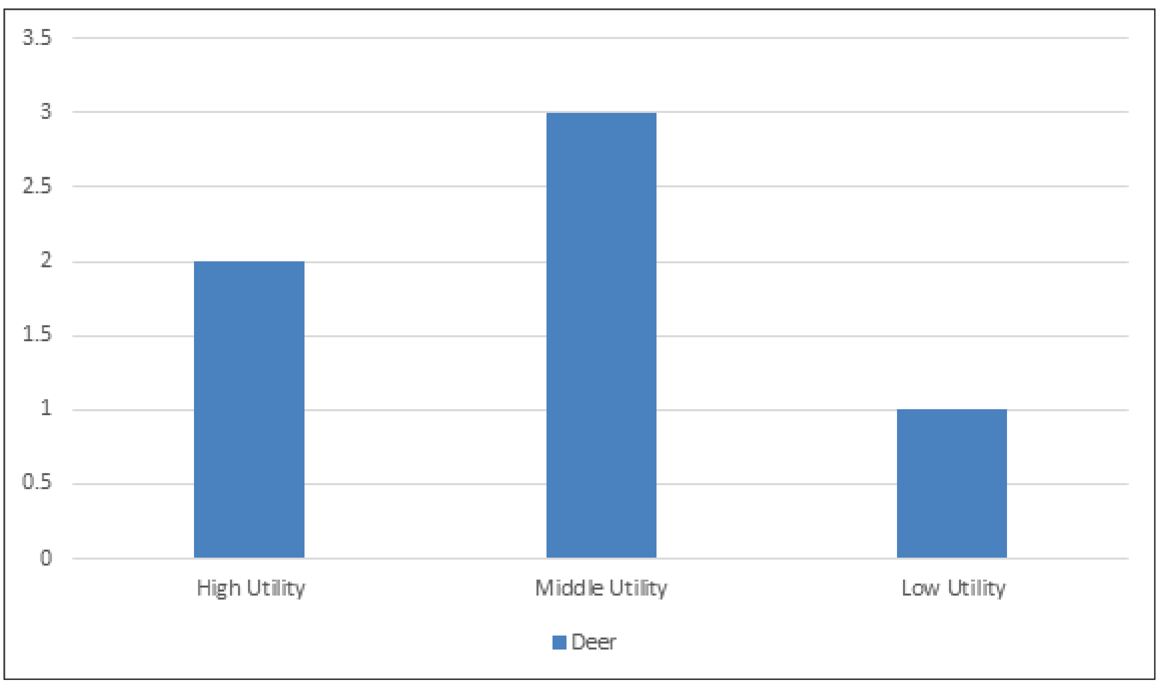

Figure J-27. Average marrow and grease utility distribution for long bone elements of white-tailed deer based on frequency of occurrence modified from Jacobson (2000).

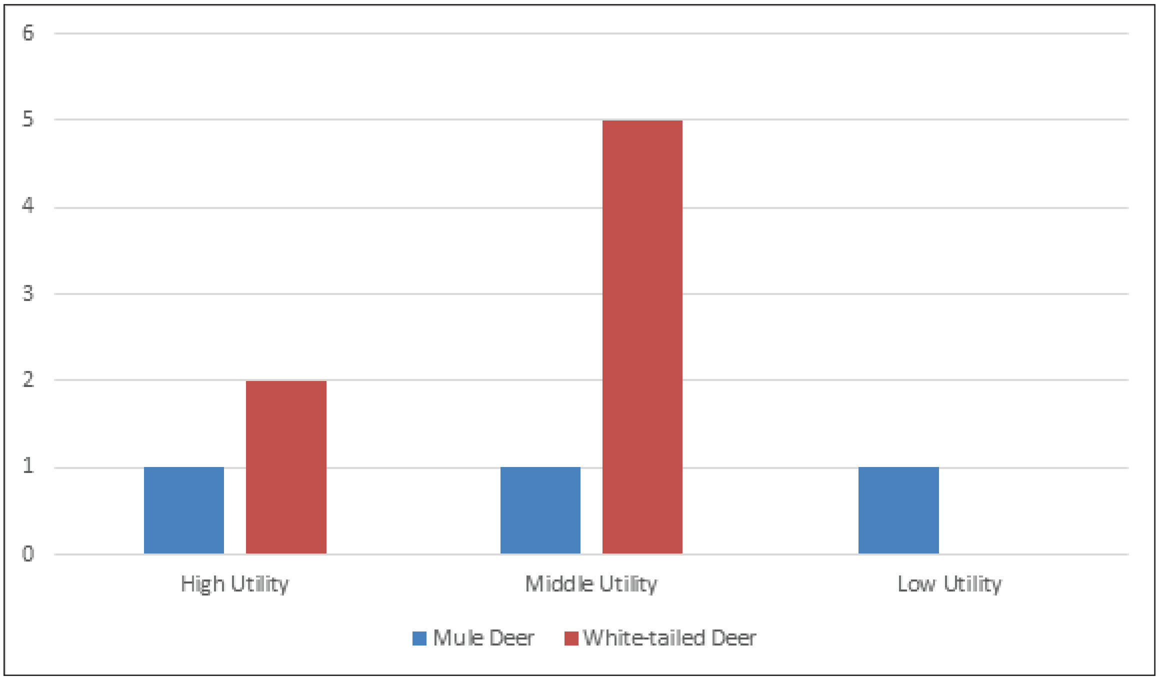

Figure J-28. Distribution of deer long bones based on marrow and bone grease utility by species.

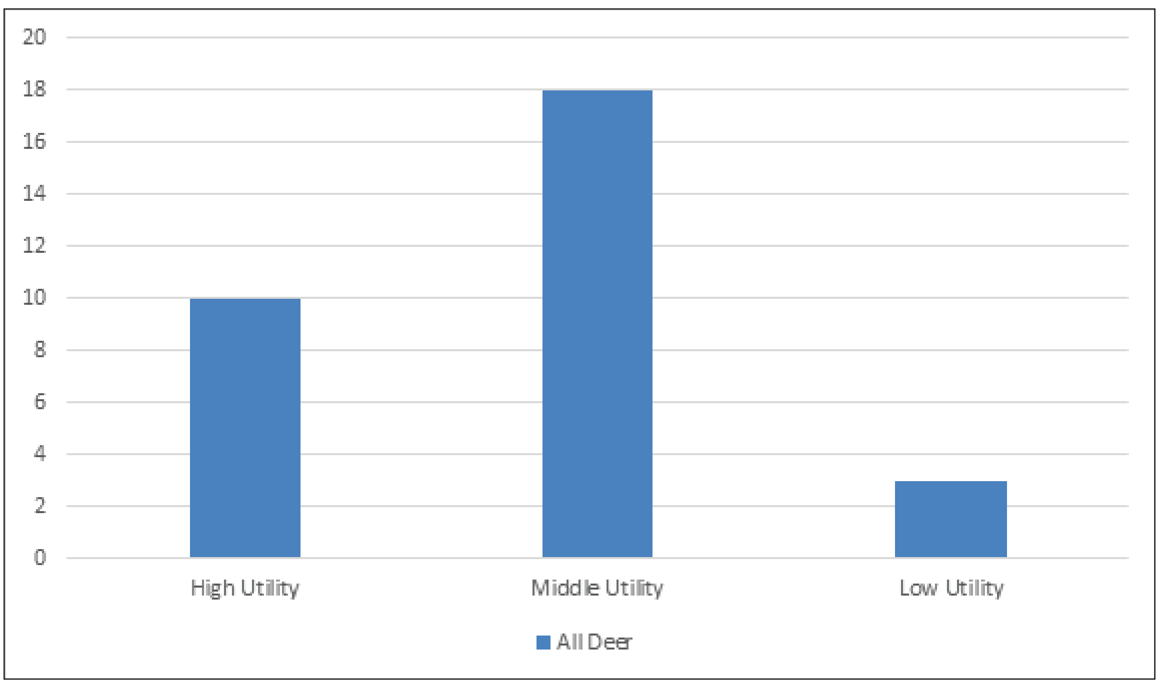

Figure J-29. Distribution of long bones by marrow and bone grease utility for all Odocoileus virginianus, Odocoileus hemionus, and Odocoileus sp. bones combined.

The minimal presence of mule deer suggests its presence overall is more rare, therefore encountered less. The overall skeletal part frequency differences between mule deer and white-tailed deer also suggests that the ecological niche from which mule deer are being hunted is at a greater distance than the niche from which white-tailed deer are being acquired. Mule deer inhabit open and scrub brush environments with some forest edge. White-tailed deer are diverse, but need riparian habitats. Earlier environmental evidence indicated that the rodents associated with grassland environments are absent. The rodents present may suggest immediate habitation area is within a riparian environment with nearby scrublands which mule deer would favor. However, based on bone grease, there is a slightly lower presence of lower utility marrow and bone grease long bones present for deer in general and white-tailed deer specifically than would occur within an animal. Multiple explanations for this exist, so it is hard to differentiate cause. The one bone associated with low utility for fat and marrow is the metacarpal. Metacarpal diaphyses are less identifiable to deer (versus pronghorn) than metatarsals as deer metatarsals have distinct features associated with the anterior groove. The metacarpal, though based on amount of fat produced is less than other long bone elements, it is one of the two elements which retains its fat reserves after fat had catabolized from the upper limb bones. The metacarpal could have been fragmented to a higher degree in seasons (early spring) when it would have remaining fat reserves whereas other higher utility bones of radius and humerus would not. As it was lower utility, other elements may have been prioritized and it provisioned to dogs at the site. All the deer metacarpals present at the site had evidence of carnivore gnawing, so it could be under-represented due to that taphonomic factor.

Bovids

Bison

Skeletal part frequencies and standardized gross utility rankings for bison were also examined. Emerson's (1990) averaged total products model was used to separate bison elements into high, middle, and low utility categories. Any elements with a unit value greater than 70 (ribs, thoracic vertebrae, and lumbar vertebrae) were considered high utility. Any elements with a unit value between 30 and 70 (cervical vertebrae, sternum, sacrum/pelvis, femur, and scapula) were considered middle utility. Any elements with a unit value less than 30 (humerus, cranial, tibia, radius/ulna, metacarpal, metatarsal, caudal vertebrae, tarsals, phalanges, and carpals) were considered low utility. While low, humeri and tibia are right on the cusp between low and middle. The general distribution of elements within these rankings is depicted in Figure J-29.

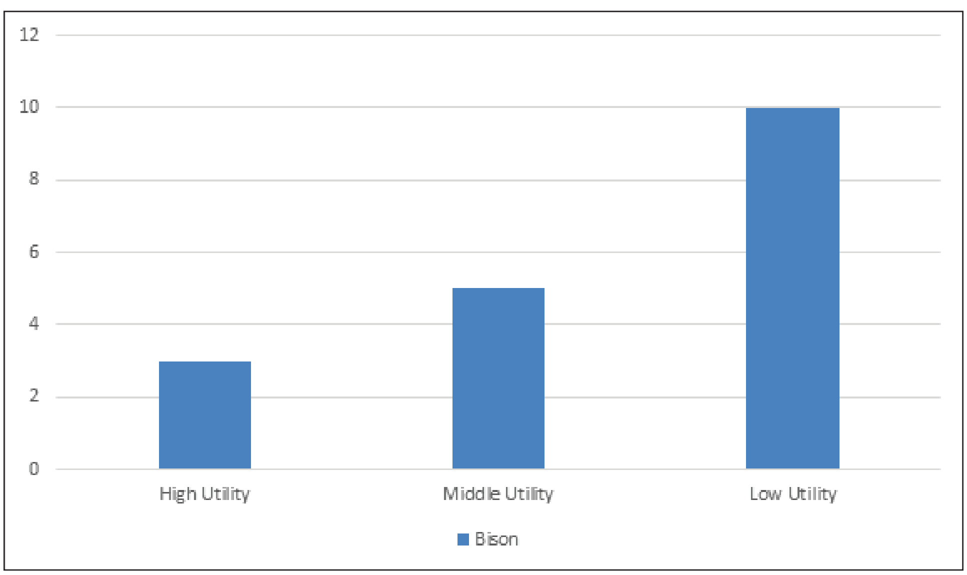

Figure J-30. Average general utility (from Emerson 1990) distribution for bison elements.

Distribution of the elements from the site for bison and other bovid from the were sorted into high, middle and low utility (Figure J-30). As can be noted, there is a much higher frequency of high utility bones than should be present at the site. Given that high utility bones of bison tend to be some of the least dense bones and therefore most susceptible to taphonomic factors, their high presence implies a specific selection strategy. There are still a fairly significant number of low utility bones, though as is noted in skeletal part frequency charts above (Figure J-31) the low utility bone that is present includes the humerus, tibia, radius, metacarpal, metatarsal and non-differentiated metapodial fragments. While having lesser meat presence than other bones, these would be excellent sources for bone marrow and bone grease. In fact, the femur, tibia, and humerus are considered high utility for marrow production, while the radius, metacarpal, and metatarsal are considered middle utility for marrow yield (Emerson 1990). Overall, bone marrow accounts for approximately 0.4 percent of total carcass weight of a bison, and can contain high quality fat even after body fat percentages are reduced in seasons of stress (Emerson 1990). In general, while overall order is somewhat different, the ranking of high and middle utility for bone grease in bison limb bones is the same as that for marrow. The total of higher utility bone grease and marrow limb bones for bovids present was 30, while 11 middle utility bone grease and marrow limb bones were present. Therefore, 41 of the 62 low utility bones present (67 percent) were high yielding in reliable fat reserves.

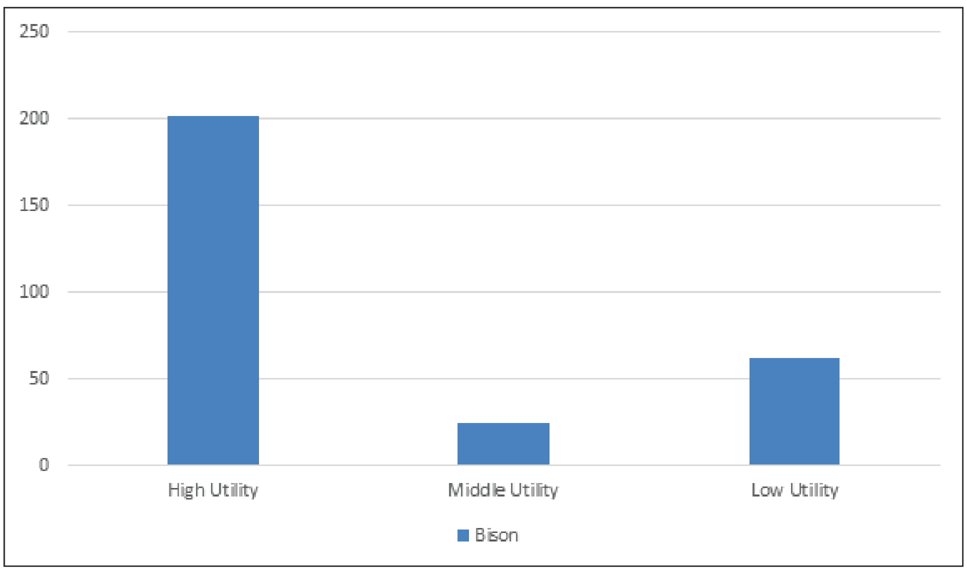

Figure J-31. Distribution of bovidae elements by general utility ranking at 41HM51.

Dockall's (2016) earlier review of the site discussed the potential of vertebrae having been processed for bone grease. Emerson (1990) ranks bone grease utility for all axial elements after that of the long bones mentioned above. The bone grease contained within the limb bones is a more predictable and stable resource than the bone grease in the axial skeleton, as axial skeleton bone grease reserves are depleted first. Within the axial skeleton, the bones with the highest bone grease utility rankings are the ribs, pelvis, and sacrum. These are followed by the lumbar and thoracic vertebrae, and last by the cervical vertebrae. Therefore, breakage for bone grease at archaeological sites should be most prevalent in the long bones first, followed by ribs and pelvis/ sacrum, with vertebrae broken as a last resource. Based on this, vertebrae would have been the last resource chosen to be broken for bone grease processing. The presence of elements with similar density suggests that the absence of vertebrae is due to other cultural selection or taphonomic causes rather than bone grease modification.

Bone Grease Vs Marrow Extraction

A primary impetus for more in-depth examination of the bone from 41HM51 has been the question of whether the intensive breakage and small fragment size of the bone was due to intentional breakage for bone grease processing or due to taphonomic factors. Indicators for intentional breakage have been presented in the previous section titled "Cultural Bone Modification" most specifically in the "41HM51 Bone Breakage" subsection. Marrow and bone grease manufacturing should not be seen as an either/or activity. Typically, marrow would be removed first before proceeding to bone grease. In fact, marrow processing would be the first logical first step in bone grease manufacturing. Since bone grease catabolizes before bone marrow, if bone marrow fat reserves are depleted then there would be little need to proceed with the labor of smashing the bone further to extract bone grease. Lower marrow fat content is suggestive that bone grease presence has already been significantly decreased and not likely to provide measurable fat. Marrow color and consistency are related to the degree of its fat component so visual cues would be available to those processing it. Nearly white marrow fat is indicative of solid stores and likely solid bone grease content, but as the marrow color turns more cream, yellow, and back towards pink and red tones the fat content is decreasing and less fat could be gained by processing the bone for bone grease. Also as the fat content decreases, the texture alters to become more gelatinous and less solid.

Size

One of the primary methods for determining whether bone was processed further would be fragment size. If processing solely for marrow, bone fragments would be larger. Site 41HM51 had numerous taphonomic factors acting as well, such as carnivore consumption, alluvial abrasion, and rodent modification. The high presence of fragile and less dense bone fragments such as deer crania and bison and medium-large sized artiodactyl ribs suggests that breakage may have been intentional and cultural or due to carnivore consumption. A comparison of overall size for carnivore modified artiodactyl bone compared to the rest of the artiodactyl bone at the site is included in Figure J-31. As can be noted in that figure, while fragmented, the degree of fragmentation for carnivore modified artiodactyl bone is not to the level as that for all artiodactyl at the site. This suggests that something else is occurring to cause that high degree of breakage beyond carnivore modification.

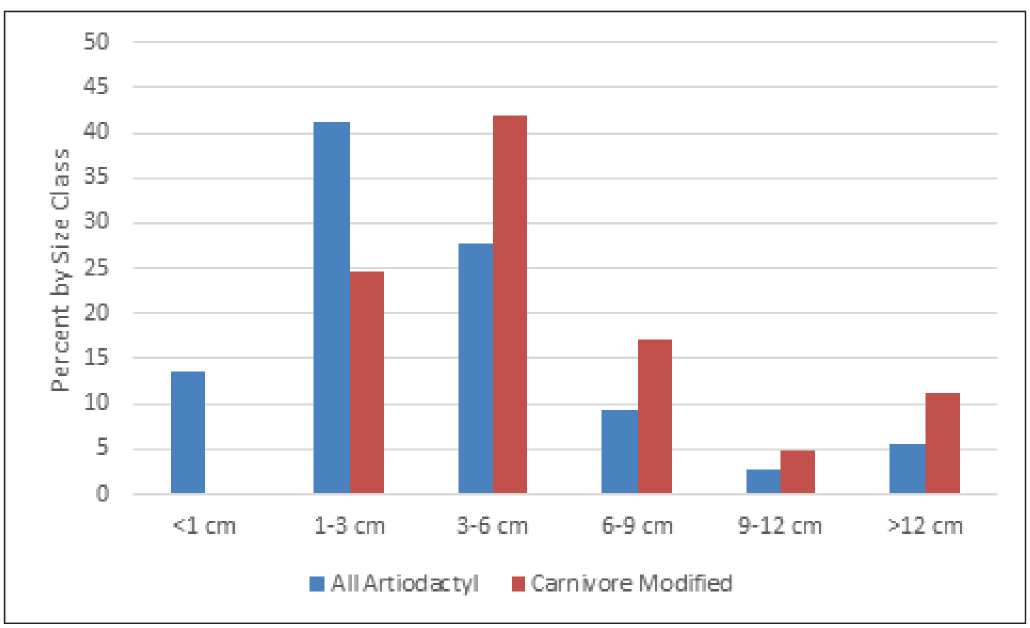

Figure J-32. Size of all artiodactyl bone versus carnivore modified artiodactyl bone.

Similar concerns on size reduction would be evident with alluvial abrasion so they were investigated as well. Figure J-32 depicts a comparison of bone size across all taxa and bone size of bones exhibiting alluvial abrasion. The bone subjected to alluvial abrasion does not consist of as small size fragments as the rest of the bone across the site. Therefore, there are other effects resulting in the small fragment size of the bone beyond that of either alluvial action or carnivore scavenging.

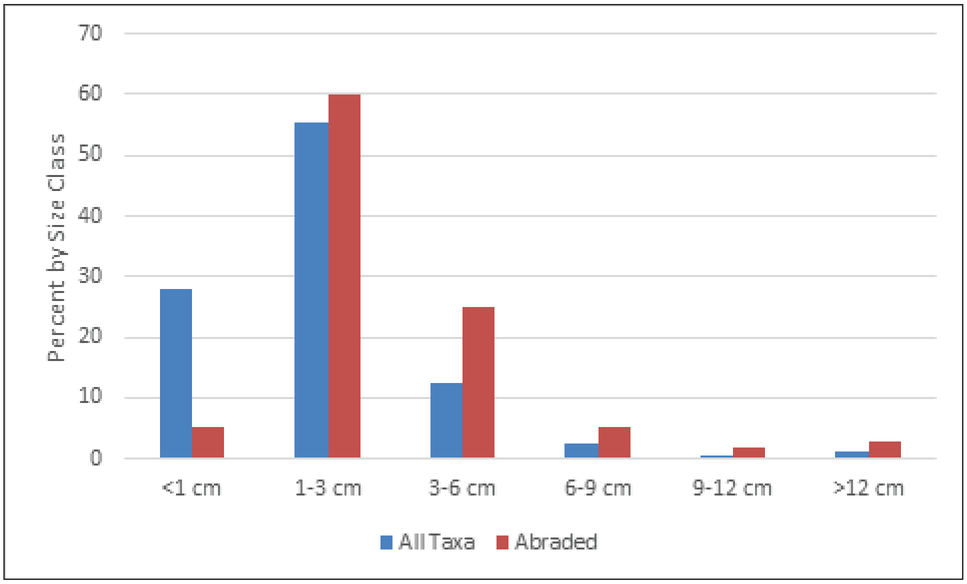

Figure J-33. Alluvial abraded bone fragment size versus the full assemblage fragments size.

Percussion Impacts and Breakage

While percussion impacts are generally associated with marrow fragmentation, repeated hitting of the bone to process it down for bone grease would result in a higher degree of percussion impacts. Over 3.1 percent (n=237) of the total assemblage exhibited percussion impacts. In contrast to other sites, the Fish Creek Slough Site (Jacobson 2014) had solid support for marrow processing at the site, yet only 0.1 percent (n=11) of the total assemblage exhibited percussion impacts and only 0.8 percent (n=6) of the artiodactyl assemblage exhibited percussion impacts. Therefore, not only is there a higher degree of these butchering marks across the whole assemblage, but of the 1,656 artiodactyl bones at the site 6.8 percent (n=112) of the artiodactyl bone at 41HM51 had percussion impacts. This higher degree of percussion impacts suggests more intensive bone modification than that from marrow processing alone.

Weathering and Thermal Alteration

Per the necessity of boiling for rendering, the bone subjected to bone grease extraction would be altered more than that for bone marrow processing. Bone processed for bone marrow alone would likely be discarded shortly after the marrow was removed. However, the need to boil the bone for grease extraction and the grease extraction itself would weaken the bone structure as the grease is what gives it plasticity and resilience. This would make bone processed for grease extraction more subject to weathering, decay, and breakage. Therefore, bone processed for marrow (or not processed at all) and deposited with bone processed for bone grease would be expected to score lower on the Behrensmeyer weathering scale than that subjected to bone grease extraction. When examining the degree of weathering for all taxa contrasted with artiodactyl bone, it is noted that there was a slightly higher degree of weathering as a whole across artiodactyl bones (Figure J-33). Artiodactyl bones are the ones most likely to have been processed for bone grease. Spatial and temporal data, unfortunately, were not ideal enough to be able to asses this on a more intra-site level analysis to identify for specific individual areas of bone grease extraction.

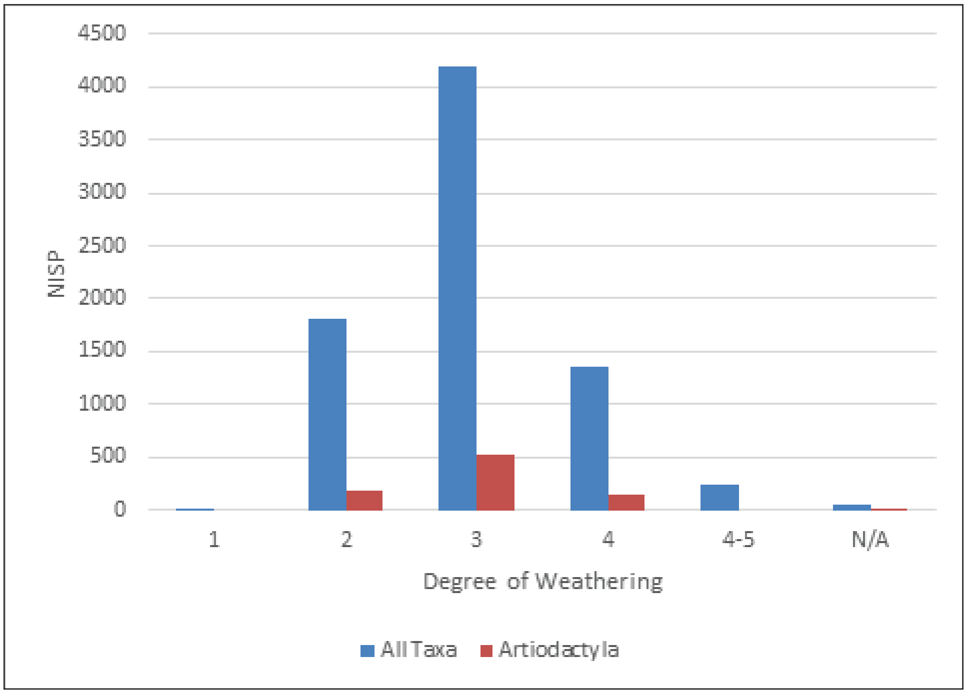

Figure J-34. Weathering of bones of all taxa versus only artiodactyla.

Ethnographic data (Vehik 1977) suggests that bone grease manufacturing would likely result in the bone having a higher degree of carbonation than that processed for marrow. If bone grease was extracted for a soup, bone fragments would be scooped out and deposited in or near the fire. If bone grease was rendered to be skimmed off, the fat would be removed as it cooled and the bone separated and deposited either in or with the charred remains of the heating fire. Due to this, it would be expected that more of the burned bone would be blackened or calcined from direct contact to the fire, in contrast to browning which would be more a result of roasting. If deposited with the ash black or white ash stains or discoloration on the surface would be likely. As the best method for opening long bones to extract marrow is hitting defleshed bone with rock, it would be less likely to be subjected to burning of any kind than that processed for bone grease. Long bones may have been seared or exposed to brief heat to weaken the bone for breakage, but marrow would need to be extracted prior to cooking to maintain the quality fat reserves. Any evidence of burning would be expected to be limited to mild browning in a localized area on the bone. Bone grease could still be extracted after cooking which could also increase the likelihood it would exhibit evidence of thermal alteration.

Approximately 10.1 percent (n=825) of the bone from the site had been subjected to thermal alteration, or it was unclear due to dark staining that seemed surficial and was unclear whether it was from surficial staining from being in context with carbonized remains or actual burning. Of the burned bone, 87 percent of the bone that had thermal alteration was blackened or calcined and only 12 percent (n=101) that had been browned. In contrast, Fish Creek slough (Jacobson 2014) which appeared to exhibit primarily marrow processing activities did have similar levels of site wide burning at 13 percent, but over 27 percent of its bone exhibited browning and 73 percent that was blackened or calcined. So while there is not an increase in frequency of burning, there is a difference in degree suggesting a different activity, such as bone grease processing.

Mortality Profiles

In order to determine if strategies for bone grease extraction could be tied into other factors (hide production, deer population dynamics, etc.) mortality profiles were examined for both deer and bison. For instance, Hides are primarily processed initially with brains not fat, but some hides are dressed with tallow. Tallow is typically made from the white body fat stores, but marrow can be used for this purpose (McCabe and McCabe 1984). Any marrow or bone grease fat being used to dress hides would need to be good quality and fairly clean of other meat and bone debris in order to be used as tallow. Fat reserves used would have to be high percent fats; therefore, it would be unlikely that any long bones with reduced reserves due to catobolization would be utilized for tallow production. While it is rare to see mortality profiles associated with hide trade until contact, it is useful to review profiles for other reasons that could result in significant processing for animal fat reserves.

Deer and bison were aged using known epiphyseal fusion progression and dental eruption and wear data (Purdue 1983; Cain and Wallace 2003 Duffield 1970, 1973.) An interesting trend emerged for deer. The largest age class of animal that was harvested were animals less than two years of age (n=51). Prime aged animals, which we have lumped as any animal with an age between two and five years of age, or which were listed as just greater than two or greater than three years old as no arthritic lipping or other signs of age were noted represent roughly half that (n=26) of the presence of animals less than two years of age. Very few deer bones were present associated with animal aged five years or greater (n=5). Typically, as deer travel individually or small maternal groups and are an encounter species rather than a gregarious herd species, selection for subsistence only would be more representative of what occurs in the environment. Herd species kills may be more targeted to either pull off easy to isolate animals (young, old, infirm) or targeted towards best meat production animals (prime aged). In archaeological assemblages, more often younger animals may be under-represented from actual harvest numbers due to bone attrition by scavengers as younger bone is less dense, and tends to be destroyed at a greater frequency than that of prime-aged animals (Purdue Klippel and Styles 1991).

Most archaeological sites with harvesting of deer geared towards subsistence are dominated by prime aged animals with some old and young represented. The significantly high presence of sub-adult deer may be an indicator of environmental factors and what is available for hunting. Following over-harvesting or other mass die-off, rebounding deer populations would be over-represented by young deer. Other natural incidents that had decimated deer population within the selection area around the site could have similar affect, so a significant flood event could not be ruled out.

Marrow and Bone Grease from Non-Artiodactyl Taxa

While generally used more due to size and overall utility, Artiodactyls are not the only animals with the potential to contain fat resources within their bones. Raccoons, canids, bears, and rabbits have been well-documented amongst various populations where marrow or other bone grease rendering has occurred. There were no bear present at the site. Raccoon and canid bones were limited in elements which could be positively identified to taxa. It is possible this was due to intentional fragmentation, but due to a lack of identifiable bone there is no data to either verify or dismiss this possibility. Raccoon presence was limited to cranial remains and one astragalus. These elements could also have been present as part of a pelt and not representative of subsistence items consumed onsite. Canid bone presence was more diverse. There were a few cranial elements and post-cranial bones included one patella, one metatarsal, a carpal, 1st phalanx and a 2nd phalanx, as well as, a young dog or coyote (6–9 months in age at death) femur, a dog or coyote ulna, a dog or coyote scapula and an indeterminate canid vertebra. All the bones were either unbroken or exhibited dry or indeterminate breaks with the exception of a cranial element that had a green break and corresponding carnivore puncture mark. However, with the exception of the young femur, the other elements are not those consistent with marrow storage and given the age of the dog/coyote femur it is young enough to still be in process of switching from blood cell production (red marrow) to fat storage (yellow marrow). The canid bone does exhibit human modification in the forms of cuts, one chop, and some burning. Cut marks on the patella would be consistent with skinning and the chop on the metatarsal could be associated with pelt or non-consumption activities. However, the shallow cuts on the dog/coyote femur diaphysis would be consistent with meat removal for consumption. Therefore, it was processed for subsistence, but the bone not processed for marrow or bone grease, again due to youth of animal fat stores would have likely been minimal. Evidence of thermal alteration was present on a tooth and first phalanx. Therefore, any statement concerning processing for bone grease or marrow extraction is not possible for these species.

An examination of rabbit bones, however, is suggestive of intentional processing of the bone. Rabbit bone has been documented ethnographically as being processed for bone grease by tribes such as the Chippewa (Vehik 1977), though typically they would break up the entire skeleton. There was no evidence for intentional breakage for any axial or cranial of rabbit bone fragments. However, of the total 42 rabbit (all Leporidae) long bone elements, exactly 50 percent (n=21) exhibited intentional spiral breaks. Four bones exhibited percussion impacts. There is no significant discrepancy in size of fragments recorded between those that exhibited spiral versus dry/indeterminate breaks, but given the starting size of rabbit bone, all would be less than 6 cm in size and most would be less than 3 cm in size when whole. Overall, however rabbit bone exhibited the lowest degree of weathering, and of the 21 bones that had evidence of intentional fragmentation, 15 of the bones scored a 2 for weathering on the Behrensmeyer (1978) scale and six bones scored a 3. Of the 21 bones that were dry or indeterminate breaks, 10 of those scored at a scale of 2 for weathering and 11 scored at a 3 for weathering. Therefore, the intentionally bone is not consistent with having been boiled for grease extraction and as breaks were limited to long bones, was likely only processed enough to allow the marrow to be removed.

FEATURE SUMMARIES

A breakdown of faunal analysis for each of the features containing bone is presented in the following section.

Feature 3

Feature 3 includes field lot #133. There is no radiocarbon date available for this feature, and it was not assigned to an occupation. The original analysts interpreted Feature 3 as a discard pile. Faunal remains from Feature 3 are minimal (n=16), including 15 unidentifiable vertebrate fragments and a single mouse (Peromyscus sp.) right mandible and incisor. All fragments are smaller than 1 cm and minimally weathered, and none show evidence of modification by either cultural or taphonomic agents. All fragments are broken with dry or indeterminate breaks.

Feature 4

Feature 4 includes field lots #134 and #135, and was not assigned to an occupation. A single radiocarbon date is available from a piece of wood charcoal (BHT 7 98.46 m), with calibrated calendrical dates of A.D. 1436–1529 (60.8 percent probability) and A.D. 1544-1634 (34.6 percent). In the initial report, Feature 4 was identified as a thermal feature with the presence of ash and a small amount of burned rock. Specifically, the original analysis interpreted the feature as an open hearth. All faunal material (n=230) recovered from Feature 4 was smaller than 3 cm in size, with 79.1 percent smaller than 1 cm. Most (n=227, 98.7 percent) were fragments of deer (Odocoileus sp.) antler that were highly weathered with a chalky texture and dry breaks. A single fragment of antler tine presented with gnawing by a mouse-sized rodent. Feature 4 also included two unidentifiable vertebrate fragments, and a single calcined bone fragment from a medium or medium-large mammal. Overall, 227 (98.7 percent) of the fragments presented with dry breaks, one fragment had an indeterminate fracture type, and the remaining two fragments were unbroken.

Feature 5

Feature 5 includes field lots #136 and #733-738 and was assigned to the Toyah occupation. There is no radiocarbon date available for Feature 5. The original analysis interpreted the feature as a discard pile. Of the faunal material collected from the feature (n=224), 183 bone fragments are unidentifiable beyond vertebrate classification and are smaller than 3 cm in size. Of these unidentifiable fragments, a majority (n=176, 96.2 percent) were smaller than 1 cm, and a small number were burned black (n=4, 2.2 percent). All were moderately weathered with dry or indeterminate break types. In addition to the unidentifiable bone fragments, Feature 5 includes remains of fish (n=2), bird (n=13), and mammals (n=26).

Fragments of catfish (Ictaluridae) bone were recovered with average weathering, dry breaks, and no evidence of cultural modification. Of the bird bone recovered, 12 were small fragments of long bone diaphyses with no modification. The last was a 6-9 cm fragment of a tarso-metatarsus diaphysis identified to the family Gruidae and may be a sandhill (Antigone canadensis) or whooping crane (Grus americana). Weathering of this specimen was slight, but all break types were dry. Cultural use is evidenced by three slim cut marks that run parallel to the bone axis. Of the mammals represented, 17 smaller fragments could not be classified beyond class. Six of these fragments had green breaks and evidence of cultural modification. A single diaphyseal fragment from a medium-large mammal displayed cutmarks and browning. Another diaphyseal fragment, also from a medium-large mammal, was blackened, and four additional bone fragments were calcined. The remaining 11 fragments of unspecified mammal bone were unmodified and had dry or indeterminate break types.

Nine additional mammal fragments could be identified further to a family or genus of artiodactyls, including deer (Odocoileus sp.) and large bovids (Bovidae and Bison bison). Deer were represented by a left distal humerus, which was identified further as a mature white-tailed deer (O. virginianus), and two fragments of an axis vertebra for an MNI of 1. All specimens were moderately weathered and showed evidence of modifications by rodents or other scavengers. The presence of a spiral fracture on the humerus indicates that the bone may have been broken to extract marrow, while the presence of an intact epiphysis suggests it was not processed further to obtain bone grease.

Large bovids were represented by a left distal tibia, a right proximal humerus, segments of one left and one right rib, and two rib fragments. All fragments were larger than 12 cm in size. Due to the age of the 41HM51 site, all large bovids are assumed to be Bison bison unless traits consistent with domestic cow (Bos taurus) are present. The tibia and humerus were both fully fused, indicating that they originated from animals at least two years old, while animal age could not be estimated for the ribs. The tibia was estimated to have belonged to a female, while sex could not be estimated for the humerus due to damage to the humeral head and trochanters. The MNI for large bovids in this feature is 1. Both long bones and the left rib segment had spiral fractures, and cut marks were found on both long bones and the lateral surface of all rib fragments. Cultural modification was further evidenced by chops to the humerus and two rib segments, as well as scraping of the tibia and left rib. All bovid fragments showed some degree of isolated smoothing and polishing. The hollowing of the humeral head and destruction of the trochanters are consistent with carnivore scavenging, further supported by the presence of carnivore scoring and isolated rounding of the fracture edge.

Feature 6

Feature 6 includes field lots #137 and #138 and is assigned to the Toyah occupation. Radiocarbon dating of a piece of wood charcoal collected from this feature gives calibrated calendrical dates of A.D. 1307-1363 (37.3 percent probability) and A.D. 1386-1442 (58.1 percent). The original analysis of 41HM51 classified Feature 6 as a thermal feature with in situ burning, no ash, and a moderate amount of burned rock that was not broken in situ. Wood charcoal was present and was primarily hickory, pecan, and hackberry. Specifically, Feature 6 was originally interpreted as a shallow earth oven or surface hearth.

Of the faunal remains recovered (n=127), almost all (n=125, 98.4 percent) were unmodified. The two modified fragments, one unidentifiable vertebrate and one mammal, were burned black. Interestingly, the burned mammal fragment displayed a green break, suggesting that it was broken prior to burning. However, only 2.4 percent of fragments from Feature 6 showed evidence of fresh fracture (n=3, including one spiral and two green breaks).

Taxonomically, the majority (n=117, 92.1 percent) of fragments could not be identified. The identified specimens are predominantly elements from smaller animals: two fragments of bird long bone, one vertebra from a small nonvenomous snake (Colubridae), and four fragments of bony fish including a scale, two rib fragments, and a fragment of catfish skull. Finally, one specimen was classified as a fragment of bone from a herptile or bony fish, and two were classified as mammal, including a fragment of dentin.

Feature 7

Feature 7 includes only field lot #139 and is the only feature from the Late Archaic occupation. There is no date available for Feature 7. The original analysis interpreted Feature 7 as a scatter of mussel shells. Faunal remains recovered from this feature were few (n=20) and all were smaller than 1 cm in size. Few fragments were modified (n=4, 20.0 percent) by burning, and only two had discernable green breaks (10.0 percent). These two green breaks were observed on the two fragments that had been burned gray. Most fragments (n=18, 90.0 percent) could not be identified taxonomically. Of the identifiable fragments, one was a skull fragment from a small catfish and the other was a diaphyseal fragment of a small bird long bone.

Feature 8

Feature 8 includes field lots #126 and #140 and has been classified to the Toyah occupation. Feature 8 was identified as a thermal feature with in situ burning in the original site analysis. The feature was characterized by an intact basin that contained 56.5 kg of burned rock that had been broken in situ. A considerable amount of plant remains were recovered from Feature 8, including a tuber and wood charcoal from elm, white group oak, and hawthorn trees. The original analysis interpreted Feature 8 as a shallow earth oven or surface hearth. Three separate radiocarbon dates are available for this feature, summarized below in Table J-19.

Table J-19. Radiocarbon Dates for Feature 8.

Provenience	Material	Calibrated Calendrical Date(s) Two-Sigma Range	Probability (%)
TU 17 97.71 m	wood charcoal	A.D. 1470-1655	95.4
TU 17 97.70 m	wood charcoal	A.D. 1318-1352	5.1
		A.D. 1390-1525	76.9
		A.D. 1557-1633	13.3
TU 17 97.82-97.61 m	charred tuber	A.D. 1441-1524	69.3
		A.D. 1559-1562	0.5
		A.D. 1571-1631	25.6

Faunal remains (n=111) recovered from Feature 8 are predominantly mammal, although a small proportion could not be classified taxonomically (n=27, 24.3 percent). There were no identifiable bird, amphibian, reptile or fish bones recovered. Roughly 74 percent of the mammal remains could be identified to a lower taxonomic level. Mammalian taxa included a single mandibular incisor of a northern raccoon (*Procyon lotor*) and medium-large and large artiodactyls (Artiodactyla), specifically large bovids (Bovidae, presumably *Bison bison* given site age) and deer (*Odocoileus* sp.). Although pronghorn (*Antilocapra americana*) were not specifically identified in this feature, they have been found elsewhere in the site and may be among the medium-large artiodactyls. The raccoon incisor was slightly burned with gray coloring and was relatively unworn, for an MNI of 1. It is unclear whether it was utilized by the site occupants or introduced by a scavenger. The bovids were represented by a single diaphyseal fragment from a proximal tibia and a large rib fragment, for an MNI of 1. A clear percussion impact is present on the tibial fragment along the fracture plane, resulting in a spiral break. Deer were represented by two complete and unmodified elements: a phalanx 3 and a distal sesamoid, for an MNI of 1.

Almost all fragments from Feature 8 are smaller than 3 cm in size (n=107, 96.4 percent) despite the fact that medium-large and large mammals were overwhelmingly represented. Approximately 93.8 percent of medium-large and large mammals in Feature 8 are represented by fragments smaller than 3 cm in size. Of these small fragments of larger taxa, only roughly five percent show evidence of fresh breaks. However, a majority of the faunal remains in this feature were burned in varying degrees including all artiodactyl rib fragments. It is difficult to determine how the prevalence of fresh breaks may have been influenced by the burning of bone, which promotes post-depositional breakage by accelerating the loss of bone integrity.

Overall, fragmentation in Feature 8 was intensive, but many of the break types were indeterminate (n=46, 41.4 percent). In addition, two recovered specimens were unbroken (1.8 percent). Of the specimens with discernable fracture types (n=63), roughly 81 percent were dry breaks and about 19 percent were fresh breaks, including a single spiral break. Burning was the most common modification (n=80, 72.1 percent) and was the only evidence of cultural modification except for two percussion impacts, one on the bovid tibia fragment and another on a mammal rib fragment. There is minimal evidence for carnivore modification (n=3, 2.7 percent) in this feature. Gnawing by mouse- and rat-sized rodents is more prevalent (n=23, 20.7 percent) and may be a minor contributor to fragmentation in this feature.

Feature 9

Feature 9 includes field lot #503 and was assigned to the Toyah occupation. A single radiocarbon date is available from a piece of wood charcoal collected from this feature, yielding a calibrated calendrical date of A.D. 1292–1520 (probability of 79.4 percent). The original report identified Feature 9 as a thermal feature with in situ burning and ash present; specifically, it was interpreted as an open hearth.

Few faunal remains were recovered from Feature 9 (n=6). All could be classified as mammal. One diaphyseal fragment could not be identified to a lower taxonomic level, but bone thickness and estimated diameter suggest a medium or medium-large mammal. This fragment had cuts on the cortical surface oriented diagonally to the long bone axis, a percussion impact with spiral break, and was slightly burned. Two diaphyseal fragments, both with spiral breaks, were classified as medium-large or large artiodactyl. Both artiodactyl long bone fragments were pitted consistent with carnivore modification, and the smaller of the two had a discernable percussion impact.

One small fragment (1–3 cm) was identified as a left deer mandible with the associated second premolar. Based on the wear of the premolar, the deer was estimated to be at least 2.5 years old. This mandible fragment and tooth were unmodified with only dry breaks. The final two fragments were identifiable as a squirrel (Sciurus sp.) left humerus, including a fully fused proximal epiphysis and a nonconjoining diaphyseal fragment. The proximal humerus fragment was unmodified and the fracture type could not be discerned. However, a spiral fracture and cut marks were observed on the diaphyseal fragment, indicating that the taxa was likely consumed.

Feature 10

Feature 10 includes field lots #745-747 and is part of the Toyah occupation. Two radiocarbon dates are available for Feature 10, summarized in Table J-20. Feature 10 is an intact basin with burned rock, broken in situ, and was identified as a thermal feature with in situ burning in the original analysis. Specifically, it was interpreted as a shallow earth oven or surface hearth.

Table J-20. Radiocarbon Dates for Feature 10.

Provenience	Material	Calibrated Calendrical Date(s) Two-Sigma Range	Probability (%)
EU 14 98.58 m	wood charcoal	A.D. 1292-1520	92.2
		A.D. 1592-1620	3.2
EU 14 98.55 m	wood charcoal	A.D. 1465-1666	93.7
		A.D. 1785-1795	1.7

A fair amount of faunal material was recovered from Feature 10 (n=200), although the majority could not be identified to class (n=160, 80.0 percent). Two diaphyseal fragments could be classified as bird long bone, both with green breaks and no modification. The remaining 38 fragments could be classified as mammalian. Eleven mammal fragments could not be classified to a lower taxonomic level but included taxa of various sizes. The other 27 specimens could be narrowed down to the mouse and rat family (Muridae), with a few identifiable to the genus (cotton rat, Sigmodon sp.) or species (Hispid cotton rat, S. hispidus) levels. Identifiable rodent elements present include various cranial fragments, a right mandible, a left maxilla, several mandibular and maxillary molars, a mandibular incisor, three vertebrae and a rib, an unfused femur and other long bone, two to four metapodials and three complete phalanges. One element, a left maxillary first molar, is present twice for an MNI of two. None of the rodent elements have been modified, suggesting that they may be intrusive.

Five rodent elements are complete. Of the fragments with a discernable fracture type, 58.0 percent have green breaks and 42.0 percent have dry breaks. Weathering is minimal in this feature, with most (84.5 percent) fragments scoring a 2 on the Behrensmeyer scale. Burning is the only modification present, affecting only 7.0 percent of the faunal material. All fragments are smaller than 3 cm in size, and nearly all (97.5 percent) are smaller than 1 cm in size. However, the apparent high degree of fragmentation in this feature is largely due to the high proportion of small sized taxa represented. Taxa size could be estimated for only 36 fragments (18.0 percent). Of these, 33 were medium or smaller sized taxa, and three were from larger taxa. Among the smaller sized taxa, almost 97 percent of fragments were smaller than 1 cm in size, while this size grade made up only 33 percent of fragments from larger taxa.

Feature 11

Feature 11 includes field lots #713-725, #748, and #750. It has been assigned to the Toyah occupation. There are two radiocarbon dates available from this feature, summarized in Table J-21. The original analysis identified the feature as a loosely concentrated scatter of debris.

Table J-21. Radiocarbon Dates from Feature 11.

Provenience	Material	Calibrated Calendrical Date(s) Two-Sigma Range	Probability (%)
EU 48 97.75 m	wood charcoal	A.D. 1295-1454	95.4
		A.D. 1485-1670	91.3
EU 48 97.72 m	wood charcoal	A.D. 1781-1799	3.7
		A.D. 1945-1949	0.4

The faunal material recovered from Feature 11 (n=213) was very diverse, including fragments from birds, bony fish, turtle, rodents, deer, and bison. Most could not be identified to class (n=165, 77.5 percent). Five fragments of bird bone were identified, including a pagostyle or penultimate vertebra from a perching bird (Passeriformes). None of the bird bones were modified. Two fragments were classified as reptiles, including a proximal left humerus from a small box turtle (*Terrapene* sp.). The humerus had shallow cut marks on the diaphysis, and may have been slightly burned, but it is difficult to distinguish from dark staining. The other reptile fragment was a neural arch of a vertebra but could not be identified to a lower taxonomic level. Seven fragments were identified as bony fish. Among these fragments two were vertebral centra, one was a scale, and three were skull fragments that could not be classified to a lower taxonomic level. A single skull fragment may have been slightly burned, but no other fish fragments were modified. A right pectoral spine, was complete, unmodified and classified to the catfish family (Ictaluridae). The spine was less than 1 cm in size and would have come from a very small catfish.

Thirty-four fragments were assigned to the class Mammalia. Nine could not be classified at a lower taxonomic level. Six were assigned to the mouse and rat family (Muridae), including a caudal vertebra, three rib fragments, and a slightly burned mandibular incisor. All other mammal specimens (n=19) represented medium-large or large artiodactyls, including large bovids (presumably *Bison bison*) and deer (*Odocoileus* sp.). Most artiodactyl specimens recovered from Feature 11 were rib fragments (n=16, 84.2 percent) and many of these were subject to post-depositional and possible post-excavation breakage. Refitting smaller fragments allowed five large bovid rib segments to be sided, including three right and two left. Of the artiodactyl ribs, seven (43.8 percent) had cut marks, usually on the lateral body surface and often found in clusters, and four (25.0 percent) were burned. A few ribs also evidenced carnivore and rodent modification.

In addition to artiodactyl ribs, a right bison proximal radius, a right deer calcaneus, and a left deer maxillary second molar were recovered. In his original report, Quigg (2014) estimated that the radius belonged to a mature female bison and noted that the radius had a spiral break. We did not receive this specimen, as it was sent to AMS for radiocarbon dating, and thus were unable to confirm his estimate and will continue analysis of this feature assuming his identification was correct. Based on the rib count and the radius, the MNI for bison in this feature is one. The deer calcaneus was unfused, indicating an individual younger than 23 months (Purdue 1983), and unmodified with an indeterminate break type. Based on the wear pattern, the deer molar also originated from a fairly young individual, allowing for a deer MNI of one. The molar is slightly burned.

Overall, most fragments (n=201, 94.4 percent) are smaller than 3 cm in size, two fragments were of intermediate size (0.9 percent), and the remaining 10 fragments were larger than 9 cm (4.7 percent). When only medium-large to large taxa are considered (n=25), about half (n=13, 52.0 percent) were smaller than 3 cm, two (8.0 percent) were between 3 and 9 cm, and another 10 (40.0 percent) were larger than 9 cm. These size grades include specimens with multiple conjoining fragments, however, conjoining pieces were separated predominately by dry breaks and were likely post-depositional. Of broken elements with discernable fracture types (n=108), 19 (17.6 percent) showed fresh fracture types including two spiral fractures and seventeen green fractures.

Feature 12

Feature 12 included field lot #749 and was not assigned to an occupation. There are two radiocarbon dates available for Feature 12, summarized in Table J-22. This feature was originally identified as a scatter of freshwater mussel shells, and the bone was recovered from the matrix between and immediately below the shells.

Table J-22. Radiocarbon Dates for Feature 12.

Provenience	Material	Calibrated Calendrical Date(s) Two-Sigma Range	Probability (%)
EU 25-28 and 81-82 98.11-97.92 m	wood charcoal	A.D. 1270-1401	95.4
EU 81 98.00 m	wood charcoal	A.D. 1410-1525	75.0
		A.D. 1557-1633	20.4

Ninety-five pieces of faunal material were recovered from Feature 12. Of these, 61 fragments could not be identified to a lower taxonomic level. The identifiable materials included smaller animals such as a perching bird (n=1), snake (n=6), bony fish (n=11), rodents (n=11), and rabbits or hares (n=5). The small perching bird (Passeriformes) was represented by the diaphysis of a tarso-metatarsus, was smaller than 1 cm in size, and was unmodified with a dry break. Snakes (Serpentes) were represented by three partial or complete vertebra, one rib head, and fragments of a right and left mandible. One vertebra fragment, the left mandible and the accompanying dentition could be identified to the nonvenomous snake family (Colubridae) and one complete vertebra could be identified to the species level, a small racer (*Coluber constrictor*). None of the snake specimens were modified, and only the rib head exhibited characteristics of a fresh fracture. It is possible that the snake specimens were intrusive.

Most fish fragments could not be identified to a lower taxonomic level, although two fragments could be identified as a small catfish (Ictaluridae). One fragment may be burned gray, but there are no other modifications. Mammal bones included only rodents and rabbits or hares. Rodent elements included two molars, a complete left rib, a radial head, two unfused long bone fragments, an ilium fragment, a possible tarsal, and three phalanges. Taxa identified include a pocket gopher (either *Geomys* sp. or *Thomomys* sp.), a kangaroo rat (*Dipodomys* sp.), and the mouse and rat family (Muridae). Two fragments are burned, and two show evidence of scavenging by a small carnivore. Five fragments of posterior dentition were identified as rabbit or hare (Leporidae).

Overall, the fauna recovered from this feature show little evidence of modification with only scant traces of burning (n=7, 7.4 percent) and some possible modification by a small carnivore (n=3, 3.2 percent). Of the broken fragments with discernable fracture types (n=63), green breaks were observed on approximately half.

Feature 13

Feature 13 includes only field lot #470 and has been assigned to the Toyah occupation. Two radiocarbon dates are available from the features, summarized in Table J-23. The feature was originally interpreted as a discard pile, and the bone was collected from the matrix immediately below the feature.

Only five faunal specimens were recovered from Feature 13, and all were identified to the deer genus, *Odocoileus*. One specimen, a right proximal radius, was identified more specifically as a mule deer (*O. hemionus*) using the formula for adult deer radii from Jacobson (2004). The radius was fully fused, indicating the deer was older than two years. There were slicing marks on the medial aspect of the diaphysis that were oriented vertically, parallel to the long bone axis.

Table J-23. Radiocarbon Dates from Feature 13.

Provenience	Material	Calibrated Calendrical Date(s) Two-Sigma Range	Probability (%)
EU 85 97.80-97.70 m	wood charcoal	A.D. 1318–1352	14.7
		A.D. 1390–1450	80.7
EU 85 97.71 m	wood charcoal	A.D. 1524–1559	3.4
		A.D. 1631–1710	26.8
		A.D. 1717–1890	49.2
		A.D. >1910	16.0

A percussion impact was also present with an accompanying spiral fracture, with some smoothing and polishing of the cortical surface, suggesting it may have been used as an opportunistic tool after marrow was extracted.

Two additional fragments of long bone diaphysis were recovered from Feature 13. The larger of the two was also consistent with a radius, with a possible percussion point, spiral break, and smoothing and polishing. Again, this may suggest that the fragment was used briefly as a tool. The smaller diaphyseal fragment was unmodified, but also had a spiral break. The final two fragments were rib fragments, both with green breaks, the larger of which could be sided as a right. This larger rib fragment had evidence of carnivore modification including scoring, smoothing, and rounding of some fracture edges.

The fragments recovered from Feature 13 are generally moderate in size, with one between 1–3 cm and the other four between 3–9 cm. All are only moderately weathered (Behrensmeyer 2–3) and have fresh breaks, three spiral and two green. Two show evidence of cultural modification, with percussion points and some indicators of cursory tool use, and one was likely modified by a medium sized carnivore.

Feature 14

Feature 14 includes field lot #751 and was assigned to the Toyah occupation. The original analysis was identified as a thermal feature with in situ burning with ash, but no burned rock, present. It was interpreted specifically as an open hearth. There are two radiocarbon dates available, summarized in Table J-24.

Table J-24. Radiocarbon Dates for Feature 14.

Provenience	Material	Calibrated Calendrical Date(s) Two-Sigma Range	Probability (%)
EU 153 97.61 m	wood charcoal	A.D. 1428-1530	60.2
		A.D. 1539-1635	35.2
EU 145 and 153 97.62-97.55 m	wood charcoal	A.D. 1441-1530	55.2
		A.D. 1540-1635	40.2

A moderate amount of faunal material was recovered from Feature 14 (n=64). Forty fragments (62.5 percent) could not be identified to class. Identifiable taxa included bird (n=3), snake (n=8), rodent (n=4), and bony fish (n=1). An additional eight fragments could be identified only to mammal. The three bird long bones were all diaphyseal fragments smaller than 1 cm in size, with green breaks, and one was burned. The snake fragments include six vertebral fragments, a cranial fragment, and a rib. Two of the more complete vertebrae could be identified as rat snakes (*Elaphe* sp.), and an additional vertebra could be specified as a nonvenomous snake (Colubridae). All snake fragments were burned, colored gray to black, and all but two had characteristics of green breaks. The bony fish fragment was unmodified.

The eight nonspecific mammal fragments were all smaller than 3 cm in size with no modification. Fracture characteristics are indicative of dry breaks. The other four mammal fragments could be identified to the mouse and rat family (Muridae), with a vertebra and phalanx identifiable to the cotton rat genus (*Sigmodon* sp.) and one mandible with dentition identifiable to species as a Hispid cotton rat (*S. hispidus*). One of these fragments was burned, gray to black. All discernable fractures were indicative of dry breaks. The other Muridae fragment included a distal left tibia and fused fibula, with unfused epiphyses.

All fragments from Feature 14 were smaller than 3 cm in size, with most (n=58, 90.6 percent) smaller than 1 cm. However, the size grade is biased based on the heavy weight of small sized taxa present. Of broken elements with discernable fracture characteristics, 43.5 percent are consistent with green breaks and the rest are consistent with dry breaks. Most of the green breaks occur in snake and bird bone, while the rest were small vertebrates. Green breaks also tightly correspond to the gray-black burning observed in this lot.

Feature 15

Feature 15 includes field lots #726-731 and was assigned to the Toyah occupation. It represents a concentration of discarded animal bones. A single radiocarbon date is available from a piece of collected wood charcoal, which gave a calibrated calendrical date of A.D. 1257–1324 (probability of 62.9 percent). A plethora of faunal material was recovered from Feature 15 (n=620), although the majority of these fragments could not be identified to a lower taxonomic level (n=445, 71.8 percent). All of the unidentifiable fragments were smaller than 3 cm, with over 95 percent smaller than 1 cm. None were modified, and all with observable fracture characteristics were consistent with dry breaks. Other animal classes recovered include amphibians (n=1), bony fish (n=10), and mammals (n=164) including medium-large artiodactyls (n=81) and deer (n=47). The amphibian specimen was identified as a salamander (*Caudata*) humerus or femur without modification. The bony fish specimens included a pharyngeal plate, three scales, a vertebral centrum, and five indeterminate fragments. Again, none were modified.

Of the mammal bones that could not be further identified, there were three alveolar fragments of maxillae or mandibles, and long bone diaphyseal fragment, and 32 indeterminate fragments. Most of these fragments were smaller than 3 cm (n=34, 94.4 percent), none were modified, and all had fracture characteristics consistent with dry breaks. Among the medium-large artiodactyl fragments, all were cranial. The largest of these fragments included an edge consistent with an open suture, suggesting that the animal was immature at the time of death. None of these cranial fragments were modified and those with discernable fracture characteristics had dry breaks.

Many identifiable fragments from this feature were from the deer genus (*Odocoileus* sp.), with 13 specimens identifiable as white-tailed deer (*O. virginianus*). Seventeen of these fragments were antler. Two antler fragments had an attached pedicle, and none were in velvet, indicating a fall seasonality for this feature (approximately October-November). The largest antler specimen had several cut marks, just above and just below the burr, along with evidence of carnivore modification. Another fragment may have been modified by a rodent. Seven deer specimens were cranial fragments including parts of the frontal, left and right temporals, sphenoid, and occipital. The spheno-occipital synchondrosis is unfused, indicating a subadult deer. None of the cranial fragments are modified.

A left and a right mandible are also present along with posterior teeth, both highly fragmentary. An additional enamel fragment was present but could not be refit. In the left mandible, the third premolar and three molars were in occlusion. There was also a loose second deciduous premolar and two loose developing permanent premolars. In the right mandible, all premolars and molars were present with permanent teeth developing but unerupted. The dental eruption and wear patterns are consistent with a deer between one and two- years of age for both left and right mandibles. The right mandible had one possible cut mark on the lateral surface of the angle, and both had evidence of carnivore modification including pitting and crushing.

The rest of the deer elements were appendicular and included a right distal tibia, a right astragalus, a right metatarsal, a right centroquatral and right fused tarsal 2 and 3, six phalanges, two vestigial phalanges, and two sesamoids. These elements were identified as white-tailed deer using classifying features from Jacobson 2004. The tibia and metatarsal were both unfused, indicating the deer was younger than two years of age at the time of death. Furthermore, the tarsals and phalanges articulate with the tibia and metatarsal from this feature, indicating that the elements derive from the same limb. Most of these elements were complete, or fragmentary but complete. There were cut marks present on the astragalus and on at least one of the foot phalanges, likely incurred during disarticulation given their placement on articular surfaces. There is also some evidence of carnivore modification, and the proximal metatarsal fragment may have been utilized as an opportunistic tool given polishing of the proximal epiphysis and slight rounding of the medial fracture edge. All fracture types appear to be dry.

Overall, the faunal evidence suggests an MNI of 1 male white-tailed deer between the ages of 1 and 2 years old at the time of death. Given the presence of the antler with attached pedicle, this deer died in the fall. The skull and right leg were ultimately transported to this site, where the leg was disarticulated. Cultural modification and carnivore activity are minimal. There is an extensive degree of fragmentation in this feature, as summarized in Table J-25. Almost 97 percent of faunal material from Feature 15 is smaller than 3 cm in size. However, all fracture planes are characteristic of dry breaks, and it is unclear how much of this fragmentation is taphonomic or post-depositional.

Table J-25. Size Grade Count and Proportion for Feature 15.

n=620	<1 cm	1-3 cm	3-6 cm	6-9 cm	9-12 cm	>12 cm
Count	484	115	14	1	1	5
Proportion (%)	78.1	18.5	2.3	0.2	0.2	0.8

Feature 16

Feature 16 includes field lots #752-754 and was assigned to the Toyah occupation. The original analysis identified Feature 16 as a thermal feature with in situ burning with a small amount of burned rock, and it was originally interpreted as a shallow earth oven or surface hearth. Wood charcoal from white group oak and elm was recovered from the feature. Two radiocarbon dates are available for this feature, summarized in Table J-26.

Table J-26. Radiocarbon Dates for Feature 16.

Provenience	Material	Calibrated Calendrical Date(s) Two-Sigma Range	Probability (%)
EU 156 98.48 m	wood charcoal	A.D. 1327-1343	2.6
		A.D. 1394-1476	92.8
EU 156 98.46 m	wood charcoal	A.D. 1307-1363	18.0
		A.D. 1385-1477	77.4

A small amount of faunal material (n=58) was recovered from Feature 16. Overall, 50 fragments had discernable fracture types, and two-thirds of those had dry breaks. A single bird long bone had a spiral fracture. Thirty-four specimens (58.6 percent) could not be identified to class, with the majority coming from small sized animals. There were possible slice marks on one unidentifiable fragment, a percussion impact on another, and three of the fragments were burned. A single fragment was pitted by a small carnivore.

Identifiable taxa were also limited to smaller animals, including birds (n=12), bony fish (n=6), amphibians (n=5), and a lizard (n=1). None of the bird specimens could be identified to a lower taxonomic level. Elements included an occipital fragment, a vertebra, a proximal left femur, fragments of six phalanges, and three long bone diaphyseal fragments. Three fragments were burned black, and these were the only modifications observed. Of the bony fish fragments, none of which could be identified to a lower taxonomic level, only one fragment was modified. This fragment was burned gray.

All but one amphibian fragment could be identified to a lower taxonomic level. A left mandible and two other mandibular or maxillary fragments, all with dentition, were classified as salamanders (Caudata). A partial eighth vertebra was classified as a true toad (Bufo sp.), likely a green toad (B. debilis) or another immature toad. None of the amphibian fragments were modified. The only reptilian fragment recovered from Feature 16 was a vertebra of a small spiny lizard (*Sceloporus* sp.); it was unmodified, as well.

Feature 17

Feature 17 includes only field lot #755 and was originally interpreted as a discard pile. A small amount of faunal material (n=31) was recovered from the matrix immediately below this feature. All fragments were smaller than 3 cm in size, with 67.7 percent smaller than 1 cm. Nine fragments (29.0 percent) were burned, and no other modifications were observed. Of the broken fragments with discernable fracture types, most (92.6 percent) had characteristics of dry breaks. Only one small bird long bone fragment displayed a spiral break, and one mammal fragment had characteristics of a green break.

Thirteen fragments (41.9 percent) were not identifiable to class. Of these, animal size could be estimated for the two larger fragments, one small to medium and one medium to medium-large. The identifiable taxa include bony fish (n=12), bird (n=1), and mammal including deer (n=1) and squirrel (n=3). Only one bony fish fragment was burned, the only modification observed in the taxa. The bird bone was also burned.

Of the mammals, only one fragment could not be identified to a lower taxonomic level. It was unmodified. Deer were represented by a single, unmodified antler fragment. There were three elements classified to the squirrel family (Sciuridae): one left mandible fragment, a complete right mandibular incisor, and an unsided mandibular incisor. The two incisors appeared to be burned, gray to black in color. The unsided incisor was different in size and was much more slender and pointed than the right incisor, suggesting that the two came from different species.

Feature Cultural Summary

Comparisons of material form features with significant bone components are contrasted with non-feature related assemblage for those components.

Late Archaic vs Feature 7

Feature 7 was the only feature with bone clearly definable to the Late Archaic component. Most fragments in Feature 7 (n=18/20, 90 percent) are from small taxa, while most of the fragments from the non-feature Late Archaic context are either indeterminate or larger taxa. Thermal alteration occurs more frequently on bone in Feature 7 than with the non-feature Late Archaic bone. Carnivore and cut marks are more common on the bone outside in non-feature context. Bone from this feature were highly fragmented. Unfortunately given the small size of both the feature and non-feature assemblage few definitive statements can be made. Given that mostly small taxa are represented, the feature does not seem consistent with bone grease processing, but cannot be ruled out based on ethnographic evidence for occasional heavy processing of smaller fauna for grease. The degree of thermal alteration and few identifiable elements present are consistent with intentionally cooked food resources.

Toyah vs Features 5, 6, 8, 10 and 11.

Multiple features were associated with the Toyah component contained bone (Features 5, 6, 8, 9, 10, 11, 13, 14, 15, 16, and 17), but only Features 5, 6, 8, 10, 11, and 15 contained substantial quantities of bone (n>100). In order to attempt to assess potential functions and bone associations with features, the frequencies for human modification to bone contained within the features were plotted against the overall frequencies for that modification within the Toyah component as a whole and are presented in Figures 34-36.

Most features exhibited only minimal presence of cutmarks or none at all (Figure J-34). As can be noted, Feature 9 and 13 do have a higher incidence of cutmarks on the bone, but each has 6 or fewer bones present, so data is inconclusive. While a minimal presence, Feature 9 also has a higher frequency of burned bone than average and higher frequency of percussion impacts than average. All bone recovered from Feature 9 was identified as mammal and included deer and squirrel. While artiodactyl bone did exhibit spiral breaks there was also carnivore modification. Overall bone fragment size varies and most are heavily fragmented (less than 3 cm) with one bone 3-6 cm in size and another 6-9 cm. Feature 9 has been described as a thermal feature with in situ burning. It is possible the bones were associated with a small-level limited bone grease extraction event, but given limited feature assemblage no definite assertions can be made.

Feature 13, however, in addition to a higher presence of cut marks also exhibited a higher frequency of percussion impacts (Figure J-36). All bone recovered from this feature were identified as deer bones, but much were larger in size (one from 1-3 cm, the remainder between 3-9 cm). None of the bone from the feature was burned. The identifiable elements included three long bones and two ribs. All of the long bone fragments had spiral fractures and the rib bones exhibited green breaks. Given the associations, Feature 13 was either a processing or disposal area with evidence for meat removal and marrow extraction. There is no evidence for bone grease extraction associated with this material.

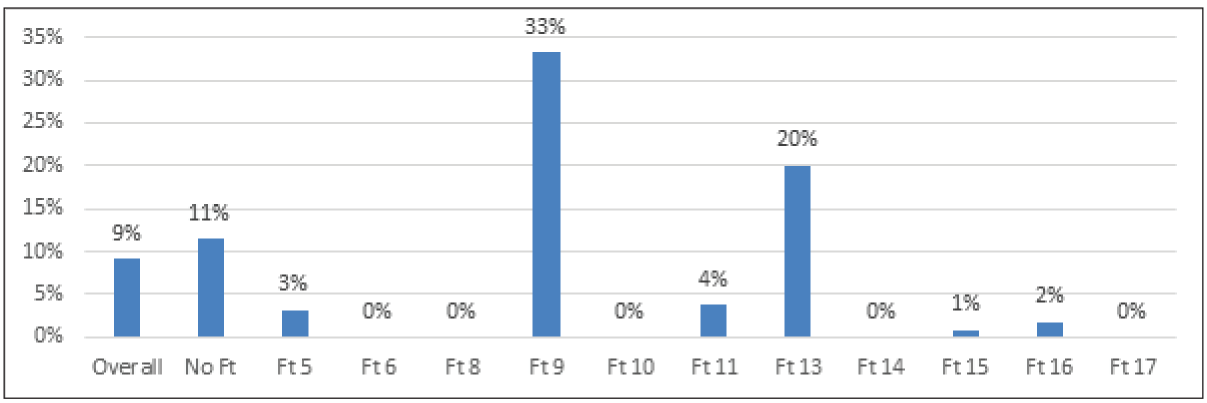

Figure J-35. Frequency of cut marks on bone in overall Toyah component and various Toyah component features.

Feature 8, however, had a substantial bone presence and a significantly greater presence of thermally altered bone (Figure 36) than the Toyah component as a whole. Feature 8 also consisted of 75 percent of the faunal remains from deer and larger sized taxa, and bone fragments were heavily fragmented with over 95 percent of the bone less than 3 cm in size. The majority of the breaks were dry or indeterminate, but 11 percent of the bone exhibited spiral fracturing or intentional breakage. There was a presence of percussion impacts similar to the frequency within the overall assemblage. The only species identified from the feature include Bovidae, deer, other artiodactyls, and raccoon. Given the high degree of comminuted bone, the higher frequency of thermal alteration, evidence for intentional breakage, and the presence of only species known to have been processed by prehistoric groups for bone grease is the clearest definite evidence for bone

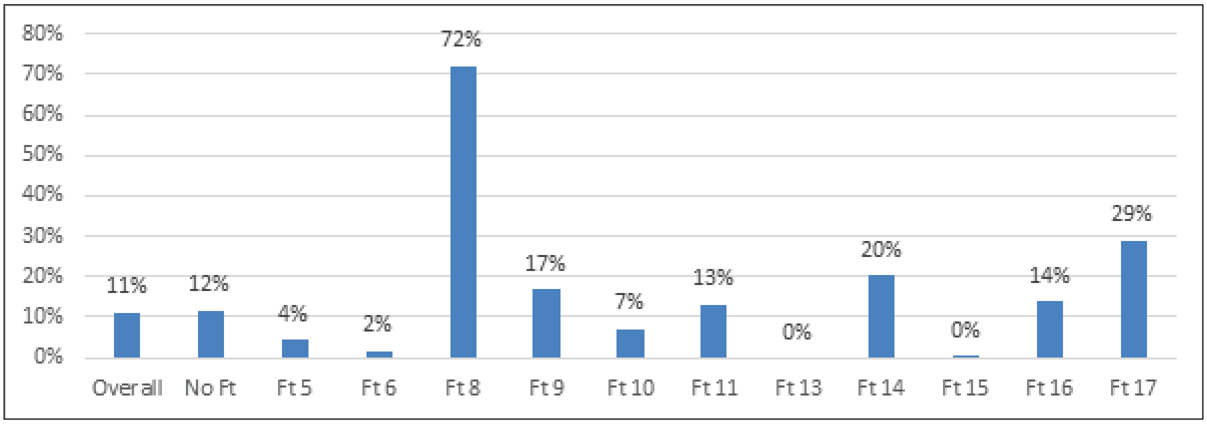

Figure J-36. Frequency of thermal alteration on bone in overall Toyah component and various Toyah component features.

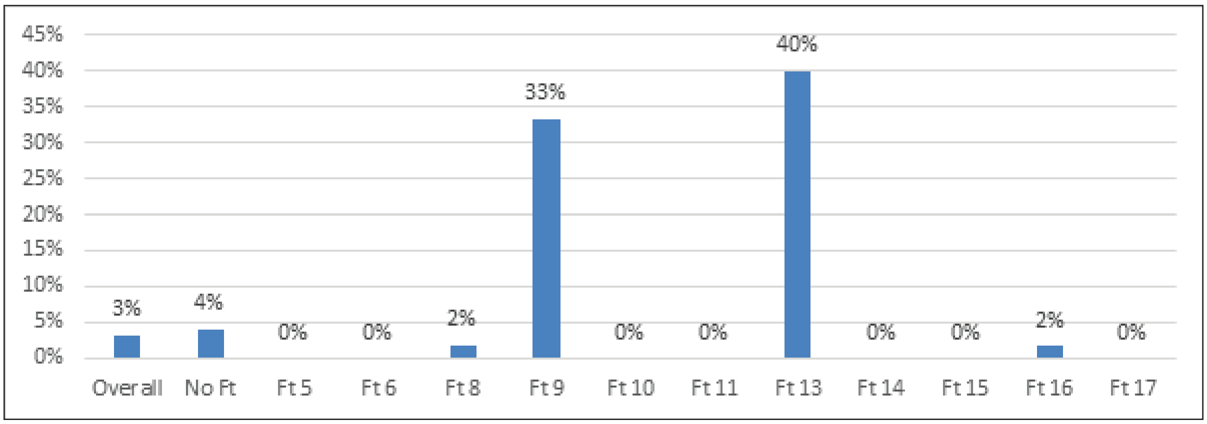

Figure J-37. Frequency of percussion impacts on bone in overall Toyah component and various Toyah component features.

grease extraction at the site. In addition, Feature 8 has been interpreted as an earth oven or hearth feature with a dense fire-crocked rock presence. Based on the defining features for identifying bone grease extraction, Feature 8 has all of the indicators.

Features 14 and 17 also have a higher presence of thermally altered bone than the remainder of the Toyah component, but there are only 64 bones from Feature 14 (only 14 of which could be identified to Class) and only 31 bones from Feature 17 (only 18 of which could be identified to Class). Feature 14 consisted of primarily very small and small taxa including bird, snake, rodent, and fish. Feature 17 consisted of one bird bone, bony fish, squirrel, and a deer antler.

Feature 11 consisted of 213 fragments, 94 percent (n=201) of which were less than 3 centimeters in size, and it is the last feature that exhibited a higher frequency of thermal alteration than the Toyah component at large. The assemblage from the feature, however, was diverse and included birds, bony fish, turtle, rodents, deer, and bison. Medium-large and larger sized animals comprised only 12 percent of the feature bone assemblage. Most of the artiodactyl fragments recovered were rib fragments with one bison radius with a spiral break and a deer tarsal and molar. While the rib fragments were small, quite a few could refit and exhibited more post-depositional breakage and no signs of intentional breakage, though rib fragments did have cut mark series associated. The small fragment size appears more related to the base size of the smaller taxa present combined with post-depositional (taphonomic) breakage of artiodactyl rib elements. The feature does not appear to exhibit characteristics for bone grease manufacture, though the one spirally fractured bison radius is indicative of some marrow extraction.

The remaining features with substantial bone presence (n>100) include Features 5, 6, 10 and 15. Feature 5 consisted of predominantly small taxa to a much higher degree than the overall Toyah components. There was a much lower frequency of culturally unmodified bone within this feature as compared with the rest of the Toyah component, but this is likely due to the small size of the taxa present and less need for processing. Feature 6 also consisted of primarily smaller taxa or bones indeterminate to class with a similar lower than overall Toyah component frequency of cultural modification. Of the 200 bones recovered from Feature 10, only 40 could be identified to class. In addition to two bird fragments there were 38 mammal bones which consisted primarily of rodents in the rat family.

Feature 15 had a substantial amount of fauna (n=620) recovered from it. There was a high degree of less than 3 cm fragments (94 percent) with half of those less than 1 cm. There were amphibians, salamander, fish, and mammals including artiodactyls and deer. All of the identifiable artiodactyl bones consisted of low utility bones including cranial elements, metatarsal, tarsals, phalanges, vestigials and sesmoids which all seem to rearticulate to the same limb along with a distal tibia fragment. Fish remains include scales and skull. Given the elements and fragments present this feature was likely a refuse discard area.

There were no features with substantial bone associated with any of the other cultural components. Bone presence within the varying Toyah component features provide a good mix of processing, cooking, marrow extraction, bone grease extraction, and refuse discard areas.

ANALYTICAL UNIT SHIFTS

Additional Cultural Summaries

Due to the alluvial drape, stratigraphy was more difficult to discern at the site. Of the 7,653 bones recovered from the site, 7,110 (92.9 percent) were recovered from the Toyah component. Due to that, the Toyah component will closely mirror the interpretations for the site as a whole. The discussion below will focus primarily on the other stratigraphic levels and how they may differ from each other and the broader site interpretation to get at a refined discussion of shifts in adaptations.

Solid dating for levels is not as refined as is ideal for discussion of changes through time or temporally associated trends. Further, since bone presence beyond the Toyah Component is minimal, scientific knowledge would be limited. Regardless, a small summary is presented below for each section.

Late Archaic

Faunal remains from the Late Archaic period were minimal (n=37), including eleven mammalian fragments, one small bird fragment, a single whistling swan fragment, one small catfish fragment, and twenty-three unidentifiable vertebrate fragments. The majority of the fragments were smaller than 1 cm (n=21), 14 fragments were 1-3 cm, and a single fragment was 3-6 cm. Most fragments (n=32) exhibit moderate weathering (Behrensmeyer 2-3) while the remaining fragments (n=5) exhibit a higher level of weathering (Behrensmeyer 4). Of the fragments recovered, 10 fragments (27.03 percent) were modified. None of the fragments have any evidence of rodent modification and a small number (n=4) show evidence for carnivore modification. There is also some evidence for cultural modification. Overall, five of the fragments showed thermal alteration, two fragments had cut marks, and one fragment showed evidence for other tool or cultural use.

Table J-27. Late Archaic Vertebrate Remains Recovered from 41HM51 Data Recovery.

Class	Taxa (Common Name)	NISP
Mammalia	Medium-large/Large Artiodactyla	2
	Medium-large Artiodactyla (deer/pronghorn/sheep)	3
	Medium-large Mammal	1
	Medium/medium-large Mammal	1
	Miscellaneous Mammal	4
	Subtotal	**11**
Aves	Olor columbianus (whistling swan)	1
	Very Small Aves	1
	Subtotal	**2**
Osteichthyes	Very Small Ictaluridae (catfish)	1
	Subtotal	**1**
Vertebrate	Miscellaneous Vertebrate	23
TOTAL		**37**

Lower Toyah

Faunal remains from the Lower Toyah period were also minimal (n=41), including five artiodactyl fragments, four mammalian fragments, five bird fragments, one small/medium turtle fragment, eleven catfish fragments, one fish fragment, and fourteen unidentified vertebrate fragments (Table J-28). Most of the fragments (n=30) were 1-3 cm, four fragments were less than 1cm, six fragments were 3-6 cm, and one fragment was 6-9 cm. Like the previous period, most of the fragments exhibited moderate weathering. However, compared to the previous context, the majority of the fragments were classified as a Behrensmeyer 3 and showed slightly more weathering. Of the fragments recovered, 14 fragments (34.15 percent) were modified. One fragment showed evidence for rodent modification and eleven fragments showed evidence for carnivore modification. Ten of the fourteen modified fragments showed evidence of cultural modification. Overall, none showed evidence of burning or chopping, one fragment had cuts, and five fragments showed evidence of other tool or cultural modification.

Table J-28. Lower Toyah Vertebrate Remains Recovered from 41HM51 Data Recovery.

Class	Taxa (Common Name)	NISP
Mammalia	Medium-large/Large Artiodactyla	2
	Medium-large Artiodactyla (deer/pronghorn/sheep)	3
	Medium-large Mammal	1
	Medium/medium-large Mammal	3
	Subtotal	**9**
Aves	Medium Aves	1
	Small/Medium Aves	4
	Subtotal	**5**
Reptilia	Small/Medium Testudines (turtle)	1
	Subtotal	**1**
Osteichthyes	Ictaluridae (catfish)	11
	Miscellaneous Osteichthyes	1
	Subtotal	**12**
Vertebrate	Miscellaneous Vertebrate	14
TOTAL		**41**

Upper Toyah

Like the previous two periods discussed above, faunal remains found to be associated with the Upper Toyah period were minimal (n=30). Present within the Upper Toyah assemblage were one jackrabbit fragment, one deer fragment, four bovid fragments, four medium-large/large artiodactyl fragments, one mammalian fragment, three fish fragments, and sixteen unidentifiable vertebrate fragments (Table J-29). The fragments associated with this culture are larger than the previous cultures discussed above. Eight fragments are 3-6 cm, four fragments are 6-9 cm, and the remaining fragments are 1-3 cm. Weathering of the fragments was similar to that of the previous sections discussed, with the majority exhibiting only moderate weathering (Behrensmeyer 2-3) and the rest being classified as a 4. Of the fragments recovered, 17 fragments (56.67 percent) show evidence for modification. One fragment showed rodent modification and nine fragments showed evidence of carnivore modification. Eleven of the eighteen modified fragments show evidence of cultural modification. Overall, one fragment had evidence for thermal alteration, three had cut marks, and seven had evidence of other tool or cultural modification.

Table J-29. Upper Toyah Vertebrate Remains Recovered from 41HM51 Data Recovery.

Class	Taxa (Common Name)	NISP
Mammalia	c.f. *Lepus* sp. (jackrabbit)	2
	Odocoileus sp. (deer)	3
	Bovidae (bison/cow)	1
	Medium-large/Large Artiodactyla	1
	Medium or larger Mammal	4
	Subtotal	**11**
Osteichthyes	Miscellaneous Osteichthyes	1
	Subtotal	**1**
Vertebrate	Miscellaneous Vertebrate	23
TOTAL		**37**

SUMMARY

41HM51 is an interesting site with a complex assemblage. Bone was subjected to multiple cultural activities including bone marrow and bone grease extraction, as well as being affected by numerous taphonomic variables. The presence of the alluvially-abraded bone was unique and only easy to identify because it occurred in such high quantity. Given the skeletal part frequencies of bison and how they vary from deer, they were killed elsewhere and the higher utility parts transported to the site, including the bones highest in marrow and bone grease. While at the site overall and within the Toyah component specifically there is clear evidence for both marrow and bone grease extraction, two features (Features 11 and 13) provide definite evidence of areas where marrow extraction occurred but bone grease extraction did not, and two features provide compelling evidence for bone grease extraction (Features 8 and 9), with Feature 8 meeting every characteristic defined at the beginning of the chapter for bone grease extraction.

Both the canid bone and the high degree of carnivore modification at the site give insight to dog domestication, which has rarely been noted in Texas archaeological assemblages. Given the size of the canid bone present, canids at the site match the description of *jupines* (domesticated dogs used as transport and hunting assist animals) in the ethnographic record. It is possible site occupants used the dogs as pack animals to transport the bison remains to the site, allowing them to extend their hunting ranges.

Environmental conditions at the site were varied and the setting is consistent with a riparian habitat with nearby dryer scrub for the Toyah occupation. A paucity of bone associated with other levels limits description during other occupations. If stratigraphy could be better refined, shifts in time could be better documented within the Toyah occupation. Seasonally there is evidence for occupation in both the fall and the spring, but it is unclear from the data if the site was occupied year-round or occupied multiple times during differing season. The Jayroe site definitely demonstrates that heavily fragmented bone is not necessarily a sign of poor preservation but can instead be due to complex cultural interactions at the site, The bone assemblage at the Jayroe site is well preserved, but was selectively processed for both marrow and bone grease.

To summarize, all of the initial research questions and goals prior to the investigations have been addressed.

Define how sites where bones were processed for marrow extraction would differ from those where marrow and bone grease extraction were conducted would present archaeologically in Texas. Different characteristics for these types of activities and how they would present archaeologically were detailed in above sections. Essentially, sites where marrow processing was present but with little to no bone grease activity should have a high proportion of larger bone fragments, a high proportion of fragments with intact epiphyses, allowing classification to taxonomic class, high proportions of fresh fractures, including spiral fractures on larger fragments of bone, a presence of recognizable percussion impacts, and green and spiral breaks on primarily marrow containing bones of long bones and mandible. Some of these characteristics will still be retained at sites where bone grease rendering is also occurring as marrow processing would be the first step. But as a whole, the assemblage associated with each analytical unit should have similar degrees of weathering and only exhibit typical browning or campfire disposal burning associated with roasting and food consumption. Sites where there was bone grease rendering activity though would have in contrast to the marrow processing evidence bones of larger taxa represented by high proportion of small (<3 cm) fragments, fragments with a higher degree of weathering relative to other bones in similar context on site, different patterns of breaks in bones of different taxa or types of long bones that correspond to available fat reserves, presence of burned bone fragments either deposited in the fire or intermingled with ash, and a presence of intentional breakage (spiral breaks) on greater range of skeletal elements, not just those with a medullary cavity.

Document to what extent bones at 41HM51 were processed for bone marrow and bone grease. Given the degree to which fragmentation exceeds that explainable by other taphonomic factors sure as alluvial abrasion, carnivore activity, and rodent modification and the overall heavily fragmented nature of the assemblage a significant amount of bone grease extraction was occurring at the site, especially during the Toyah component. However, there are bones that have not been processed and those are indicative that some selective processing was being conducted based on visual cues for a specific bone's overall likelihood to contain marrow fat based on body fat deposits such as those on the kidney, and for elements to contain sufficient bone grease based on the visual cues and quality of the marrow fat. Rather than mass processing of all artiodactyls at all times, bones were processed throughout the occupation and selection of elements dependent on good return potential. Two features provide additional evidence for areas within the site where bone grease manufacturing activities directly occurred.

Compare skeletal element presence with potential for bone grease yields and how that may vary based on season of death as determined through analysis of age profiles or other associated animal seasonal characteristics. Unfortunately, due to finer resolution of occupations not being available and evidence for use of the site during all seasons, any statement on seasonal variation in activity is not possible. However, age profiles do indicate that young artiodactyls whose bones had not yet switched form red marrow (blood cell production) to yellow marrow (fat storage) were not being broken and utilized for either marrow or bone grease.

Determine conclusively whether the comminuted bone recovered from the site was due to bone grease extraction by human occupants of the site or due to taphonomic processes such as prolonged exposure prior to burial, trampling, etc. The evidence is clear that while some degree of breakage at the site is as a result of other taphonomic factors including alluvial tumbling and carnivore scavenging, the degree of fragmentation and size of the bone is much greater than for which those factors can account. Furthermore, a much higher incident of percussion impacts and intentional human breakage of bone is present at the site than at other Texas sites where marrow processing has been identified. The site clearly meets all the characteristics of a site for which bone grease rendering was a regular activity.

Evaluate non-ungulate species such as canids, raccoons, and rabbits that have historically demonstrate potential for grease extraction to determine if processing of bone grease, if present, was limited to ungulate only species or other animals as well. While there was no evidence for specific use of bone grease or marrow for canids or raccoons, there is evidence at the site for intentional breakage of rabbit long bones for marrow extraction. Evidence does not suggest that further breakage or rendering of bone grease from rabbit bones was occurring. Given the degree of labor and amount or fuel required to extract, rabbit bones may have been seen as low priority for this resource with attention focused on larger artiodactyl species which could produce a greater quantity of fat.

Evaluate previously conducted feasibilities and studies and determine their accuracy based on the current data and information. With respect to Quigg's (2014) original report, our taxonomic classifications matched the original classifications in approximately half of specimens and our skeletal element identifications matched approximately 60 percent of the time. Likely due to time constraints, Quigg's classifications were frequently left at broader taxonomic categories, but few outright errors were made (2.1 percent of the assemblage). Errors were more common when it came to skeletal element identification (25.3 percent of the assemblage), although the majority of "errors" resulted from closer looks at previously unidentifiable, often small elements under the microscope. Dockall's (2016) study drew largely from Quigg's original data, and his interpretation consequently suffered from existing inaccuracies in taphonomic data. Additionally, the use of FFI to examine bone grease production is a flawed approach due to the increased susceptibility of boiled bone to post-depositional breaks. Dockall's study assumed taphonomic reasons for commutation of the bone without investigating in depth the taphonomic factors most likely to impact it. Altogether, the current study was able to discern information that previous researchers could not due to an increase in time available for observations, analysis by individuals with greater skill in assessing degrees of taphonomic modification to bone, and a more thorough understanding of the intended application of FFI.

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APPENDIX K: AMATERRA SITE SPREADHSEET HYPOTHESIS 2

Site #	Site Name	Phase	Results	Hearth/ Cooking Pits	Burned Rock	Cominuted Faunal Remains	Diverse Lithic Tool Assemblage	Groundstone/Anvil Stones	Hammer-stones	Lipid Residues	Ocher	Taphonomic Issues?	Other Comments
41WM235	Wilson Leonard	Paleoindian	Maybe	?	X	X	X	X	X		X	Fauna shows evidence of pre- and post-depositional breakage	Highly frag fauna and suggests marrow extraction likely. Although this component has all the signatures of bone grease extraction the authors questions possibility of grease extraction based on high % of burned bones though articular ends show less burning than cortical bone.
41TG91	East Levee	Archaic	Maybe	X	X	?	X	X			X		Only Toyah fauna anaylzed in detail.
41WM235	Wilson Leonard	Archaic	Maybe	X	X	X	X	X	X		X	Fauna shows evidence of pre- and post-depositional breakage	Highly frag fauna and suggests marrow extraction likely. Although this component has all the signatures of bone grease extraction the authors questions possibility of grease extraction based on high % of burned bones though articular ends show less burning than cortical bone.
41HY202	Barton	Early Archaic	No	X	X		X						
41UV88	Woodrow Heard	Early Archaic	Yes	X	X	X	?	X	X				
41HY202	Barton	Late Archaic	No	X	X	?							
41HY209	Mustang Branch	Late Archaic	Yes	X	X	X	X	X	X				Bone grease suggested by authors.
41KM69	Flatrock Road	Late Archaic	Maybe	X	X	X	X			?		Intrusion of groundhog & armadillo possible	
41MM341	J.B. White	Late Archaic	Maybe	X	X	?	X	X	X	?			
41WM1126	Siren Site	Late Archaic	Yes	X	X	X	X	X			X		
41BL104	Evoe Terrace	Austin	Yes	?	X	X	X	X	X		X	All late prehistoric materials mixed, though mostly Austin Phase material.	
41BN33	Rainey Sinkhole	Austin	No	X			X					serially utilized shelter	
41BT105	Lion Creek	Austin	Indeterminate	X	?	?	X	X			X		2 midden areas looted. Early excavation poorly documented and no faunal material preserved/collected.
41FY42	Frisch Auf!	Austin	No										Very small non-burial assemblage, though report focused primarily on burials.
41HY202	Barton	Austin	No	X	X	?	X						
41HY209	Mustang Branch	Austin	No	X	X	X	X	X	X				Although no solid evidence of bone grease extraction found for Austin component, bone grease extraction is posited for Late Prehistoric component
41KM69	Flatrock Road	Austin	Maybe	X	X	X	X			X		Intrusion of groundhog & armadillo possible	highest frequency of thermal features at the site
41LL419	Graham-Applegate	Austin	Indeterminate		X			X					Report on flora only. Definite evidence for cooking onion and yucca
41TV51	Jetta Court	Austin	Yes	?	X	?	X	X	X		X		Condition of faunal assemblage not reported
41TV88	Pat Parker	Austin	No			?	X	X				Notes disturbance to site area	Excavation focused on burials rather than midden component
41WM1010	Shepard Site	Austin	Maybe	X	X	X	?						
41WM1126	Siren Site	Austin	Yes	X	X	X	X	X					
41WM230	Loeve Fox	Austin	Indeterminate	X		?						Midden material mixed into cemetery fill	
41ZV202	Zavala Site	Austin	No	X	X	X	X						
41BC114	Wheatley	Austin/Toyah	Indeterminate	X	X	?	X	X	X			Little fauna recovered, possibly due to preservation.	Either overlapping or transitional Late Prehistoric components
41CM1	Oblate	Austin/Toyah	Indeterminate	X	?	?	X	X			X		Faunal assemblage poorly documented
41HI1	Kyle Shelter	Austin/Toyah	Indeterminate	X		?	X	X	X		?	Site has been looted since initial excavation.	Little of the faunal assemblage collected or described beyond taxa list. Painted stones present.
41MM341	J.B. White	Austin/Toyah	Yes	X	X	X	X	X	X	?			
41SS178		Austin/Toyah	No	?	X	?	X				X		Faunal assemblage sm. and not fully described in size, though many pieces unidentified mammal. Sig. amt. of mussel shell in cultural zone identifed soley to Austin Phase
41TV42	Smith Rockshelter	Austin/Toyah	Indeterminate	X	X	?	X	X	X				No detailed description of condition of faunal assemblage

Site #	Site Name	Phase	Results	Hearth/ Cooking Pits	Burned Rock	Cominuted Faunal Remains	Diverse Lithic Tool Assemblage	Groundstone/Anvil Stones	Hammer-stones	Lipid Residues	Ocher	Taphonomic Issues?	Other Comments
41TV441	Toyah Bluff	Austin/Toyah	Yes	X	X	X	X	X	X		X	Site preservation impacted by flood events.	Toyah overprinted onto Austin Phase deposits
41WM130	Hoxie Bridge	Austin/Toyah	Maybe	X	X	X	X				X	Vertical separation of Austin and Toyah components not possible.	Burn/breakage patterns suggest roasting or grilling of meat.
41WM235	Wilson Leonard	Austin/Toyah	Maybe	X	X	X	X					Fauna shows evidence of pre- and post-depositional breakage	Highly frag fauna and suggests marrow extraction likely. Questions possibility of grease extraction based on high % of burned bones though articular ends show less burning than cortical bone.
41BN33	Rainey Sinkhole	Toyah	No	X		?	X					serially utilized shelter	Description of faunal assemblage lacking in some details
41ED28	Varga Site	Toyah	Maybe	X	X	X	X			X		Serially utilized campsite	Meat and marrow lipids identified on some FCR. Ceramic residues suggest cooking of plants. Fauanl evidence not suggestive of large kill-events.
41GD4	Berclair	Toyah	No			?	X						Sm lithic assemblage and little detail on the condition of the faunal assemblage
41HM51	Jayroe Site	Toyah	Yes	X	X	X	X	X	?		X		
41HY202	Barton	Toyah	No	X	X	X	X					Bone frag not consistent with grease extraction	Marrow Extraction Likely
41HY209	Mustang Branch	Toyah	Yes	X	X	X	X	X	X	X			
41JW8	Hinojosa	Toyah	Yes	X	X	X	X	X	X			Majority of overall assemblage recovered within plowzone; possible post-depositional breakage.	"Bone bed" could be a disposal area or a processing area.
41KM16	Buckhollow	Toyah	Yes	X	X	X	X	X					
41KM226	Little Paint	Toyah	Yes	X	X	X	X	X	X		X		Little detail on faunal material
41KM69	Flatrock Road	Toyah	Maybe	X	X	X	X			X		Intrusion of groundhog & armadillo possible	Highest amt. of faunal remain in site
41LK201	Possum Creek	Toyah	Maybe	?	X	X	X	?			X		There is little FCR in the Late Prehistoric component
41ML35	Baylor	Toyah	Maybe	X	X	?	X	X	?			Part of south end of site showed evidence of looting	Description of faunal assemblage not detailed in terms of av bone frag size and taphonomy.
41SP220		Toyah	No	?		X	?					Taphonomic signature of post-depositional breakage, though some cortical bone fractures similar to breaks found in cases of marrow extraction	
41SS20	Finis Frost	Toyah	Indeterminate	X		?	X	X					Assemblage not discussed in enough detail to make a determination.
41TG346	Rush	Toyah	Yes	X	X	X	X	X	X	X	X		Marrow extraction definitely and grease extraction very likely.
41TG91	East Levee	Toyah	Yes	X	?	X	X	X	X		X		
41WM230	Loeve Fox	Toyah	No			?						Midden material mixed into cemetery fill	No structural features assoc with this cultural component
41WM437	Rowe Valley	Toyah	No	X	X	X	X		X			Most of faunal breakage appears post-depositional	Only a fraction of the overall faunal assemblage was analyzed.
41WM71	Barker	Toyah	Indeterminate		X	?	X	X				Site looted and disturbed by use as Boy Scout campsite.	Faunal assemblage not described in detail and minimal collection during surface collection.

APPENDIX L: AMATERRA SITE SPREADSHEET HYPOTHESIS 3

Author(s)	Pub. Date	Cultural Group	Time Period	Bone Grease in Literature Review
Denig, E.T. and J.N.B. Hewitt	1930	Assiniboine	mid 19th Cen	Pemmican production and storage; Grease Paint
Dusenberry, V.	1960	Assiniboine	1851-1960	Pemmican production
Long, J.L., M.S. Kennedy and W. Standing	1961	Assiniboine	1888 onward	Grease extraction; Pemmican production and use; Topical applications of grease to the skin
Rodnick, D. and US Bureau of Indiana Affairs	1938	Assiniboine	1906-1938	Pemmican production, storage & ceremonial/medicinal uses
Kennedy, D. and J.R. Stevens	1972	Assiniboine	17th-early 20th cen	Grease extraction; Pemmican Trade with Euro-Americans
Miller, D. and J. Beierle	2002	Assiniboine	n/a	Grease extraction; Pemmican production; Bone grease as sealant
Ewers, J.C.	1958	Blackfoot	1780-1955	Pemmican Trade with Euro-Americans; Pemmican production
Forde, C.D.	1950	Blackfoot	unspecified	Pemmican production; Food caches/storage
Grinnell, G.B.	1962	Blackfoot	late 19th, early 20th Cen	Grease extraction; Pemmican production; Grease paints
Lancaster, R.	1966	Blackfoot	post 1870	Leather goods eaten in starvation years
Schultz, J.W.	1980	Blackfoot	c. 1850-1900	Pemmican as a feast food; Food sharing and pemmican
Schultz, J.W. and J.L. Donaldson	1930	Blackfoot	1700s-1870s	Grease extraction; Pemmican production and preservation
Wissler, C.	1910	Blackfoot	c. 1800-1905	Grease extraction; Pemmican production; Grease paints; Pemmican trade with Euro-Americans
Dempsey, H.A.	1986	Blackfoot	1600s-1970s	Pemmican at gatherings/ceremonies
Nugent, D.	1993	Blackfoot	1730-1830	Pemmican production; Pemmican in food sharing
Hungry Wolf, A.	1977	Blackfoot	1850-1972	Grease paints
Hungry Wolf, B.	1980	Blackfoot	not specified	Grease Extraction; Grease in soups
Goodwin, G.C.	1977	Cherokee	1540-1775	Pemmican production; Bear grease used in topical applications & insect repellant
Birket-Smith, K.	1930	Chipewyan	1900-1925	Pemmican production; suggests pemmican adopted from the Cree
Brumbach, H.J. and R. Jarvenpa	1997	Chipewyan	prehist-1990	Pemmican production common on village-centered hunts
Jarvenpa, R. and H.J. Brumbach	1995	Chipewyan	late 18th Cen-1990s	Grease extraction and storage
Smith, D.M.	1982	Chipewyan	1786-1974	Pemmican production and storage; Fish pemmican
Gelo, D.J.	2006	Comanche	1700-1984	Pemmican production, storage, use & status as prestige food
Wallce, E. and E.A. Hoebel	1952	Comanche	1700-1945	Pemmican production; Grease in arrow shaft straightening
Voget, F.W.	2001	Crow	1780-1998	Pemmican production; Stone boiling in rawhide kettles; Grease paints; Grease in hide preparation; Trade
Wildschut, W. and J.C. Ewers	1960	Crow	1805-1927	Pemmican as a feast food
Lowie, R.H.	1924	Crow	1830-1916	Grease extraction; Pemmican Production; Pemmican as a feast food; Grease Paint
Lowie, R.H.	1935	Crow	1825-1931	Grease extraction; Stone boiling in rawhide containers
Morgan, L.H.	1959	Crow	1827-1862	Grease paints
Opler, M.E.	1941	Eastern Apache	1840-1886	Pemmican production; Grease paints
Henriksen, G.	1973	Innu	1900-1973	Ritual use of grease and marrow; Pemmican production
Lips, J.	1947a	Innu	1800-1947	Pemmican production
Lips, J.	1947b	Innu	1800-1947	Grease Extraction; Pemmican Production and storage
Tanner, V.	1944	Innu	1634-1944	Pemmican production
Honigmann, J.J.	1954	Kaska	1800-1945	Pemmican production and storage; Grease paints; Topical applications of bone grease
Basehart, H.W.	1970	Mescalero Apache	1849-1861	Food storage
Kelly, I.T.	1934	Northern Paiute	1870-1930	Grease Extraction; Pemmican production; Grease paints
Holzkamm, T.E., V.P. Lytwyn, and L.G. Waisberg	1988	Ojibwa	"traditional"-1850	Fish oil extraction; Fish Pemmican
Mead, M.	1932	Omaha	1890-1931	Women made Pemmican
Dorsey, J.O.	1884	Omaha	1870-1884	Grease extraction

Author(s)	Pub. Date	Cultural Group	Time Period	Bone Grease in Literature Review
Murie, J.R. and D.R. Parks	1989	Pawnee	1900-1920	Grease mixed with parched corn; Grease Paints
Weltfish, G.	1965	Pawnee	late 19th, early 20th Cen	Grease extraction; Topical applications of grease/fats
Olson, R.L.	1936	Quinault	1800-1890	Grease extraction; Pemmican-like foodstuffs
Arnon, N.S. and W.W. Hill	1979	Tewa Pueblos	1540-1979	Trade with Plains groups
Cooper, J.M. and R. Flannery	1957	The Gros Ventres	1835-1907	Grease extraction; Pemmican production; Grease paints
Flannery, R.	1953	The Gros Ventres	1835-1885	Pemmican production
Kroeber, A.L.	1908	The Gros Ventres	1800-1901	Pemmican production; Topical applications of bone grease
Emmons, G.T. and F. De Laguna	1991	Tlingit	1700s-1910	Grease extraction; Grease paints
Callaway, D., J.C. Janetshi and O.C. Stewart	1986	Ute	1650-1986	Pemmican production and storage
Jorgensen, J.G.	1980	Ute	8000 BC-1964	Pemmican production
Smith, A.M.	1974	Ute	9000BC-1937	Grease extraction; Pemmican production; Topical applications of grease/fats
Buskirk, W.	1986	Western Apache	1800-1950	Grease extraction; Grease and marrow in soups
Mason, L.	1967	Western Woods Cree	1611-1940	Pemmican production; Grease paints; Topical applications of grease/fats
Kneale, A.H.	1950	Navajo	1923-1929	Bones collected from desert to be crushed and boiled in soup during times of scarcity
Le Clercq, C. and W.F. Ganong	1910	Mi'kmaq	1675-1690	Grease extraction
Swanton, J.R.	1942	Caddo	1686-1875	Grease storage; Grease paint; grease in Euro-American trade; Grease in foodstuffs
Swanton, J.R.	1946	Eastern Tribes	17th-19th Cen	Grease extraction; Topical applications of grease/fats
Hodge, F.W.	1907	Various	various	Pemmican production
Hunnicut, H.M. (transl.)	1738	Apaches	1717-1805	Trade with Euro-Americans (meat and hides)
de Gorraez, J. and Hunnicut, H.M. (transl.)	1756	Bidais	1717-1805	Trade with Euro-Americans (hides)
Cabeza de Vaca, Alvar Nuñez	1542	Various TX/NM groups	1527-1537	Trade with Europeans